NAVSHIPS 92004

INSTRUCTION BOOK

for

ECHO BOX
TS-311B/UP

JOHNSON SERVICE COMPANY
MILWAUKEE, WIS.

BUREAU OF SHIPS NAVY DEPARTMENT

NAVSHIPS 92004

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Contract NObsr-52618—Approved by BuShips August 3, 1953

LIST OF EFFECTIVE PAGES

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 993-100
3 August 1953

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Echo Box TS-311B/UP NAVSHIPS 92004

1. This is the instruction book for the subject equipment and is in effect upon receipt.

2. When superseded by a later edition, this publication shall be destroyed.

3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense Publications.

4. All Navy requests for NAVSHIPS Electronics publications should be directed to the nearest District Publications and Printing Office. When changes or revised books are distributed, notice will be included in the Bureau of Ships Journal and in the Index of Bureau of Ships General and Electronics Publications, NAVSHIPS 250-020.

W. D. LEGGETT JR.
Chief of Bureau

RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

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INSTALLATION RECORD

Contract No. NObsr-52618 Date of Contract 20 June 1951

*Serial number of equipment*____________________

*Date of acceptance by the Navy*____________________

*Date of delivery to contract destination*____________________

*Date of completion of installation*____________________

*Date placed in service*____________________

Blank spaces on this page shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date of acceptance plate located below the model nameplate of the equipment, using suitable methods and care to avoid damaging the equipment.

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of Bureau of Ships Manual or superseding instructions on the subject of Radio-Safety precautions to be observed.

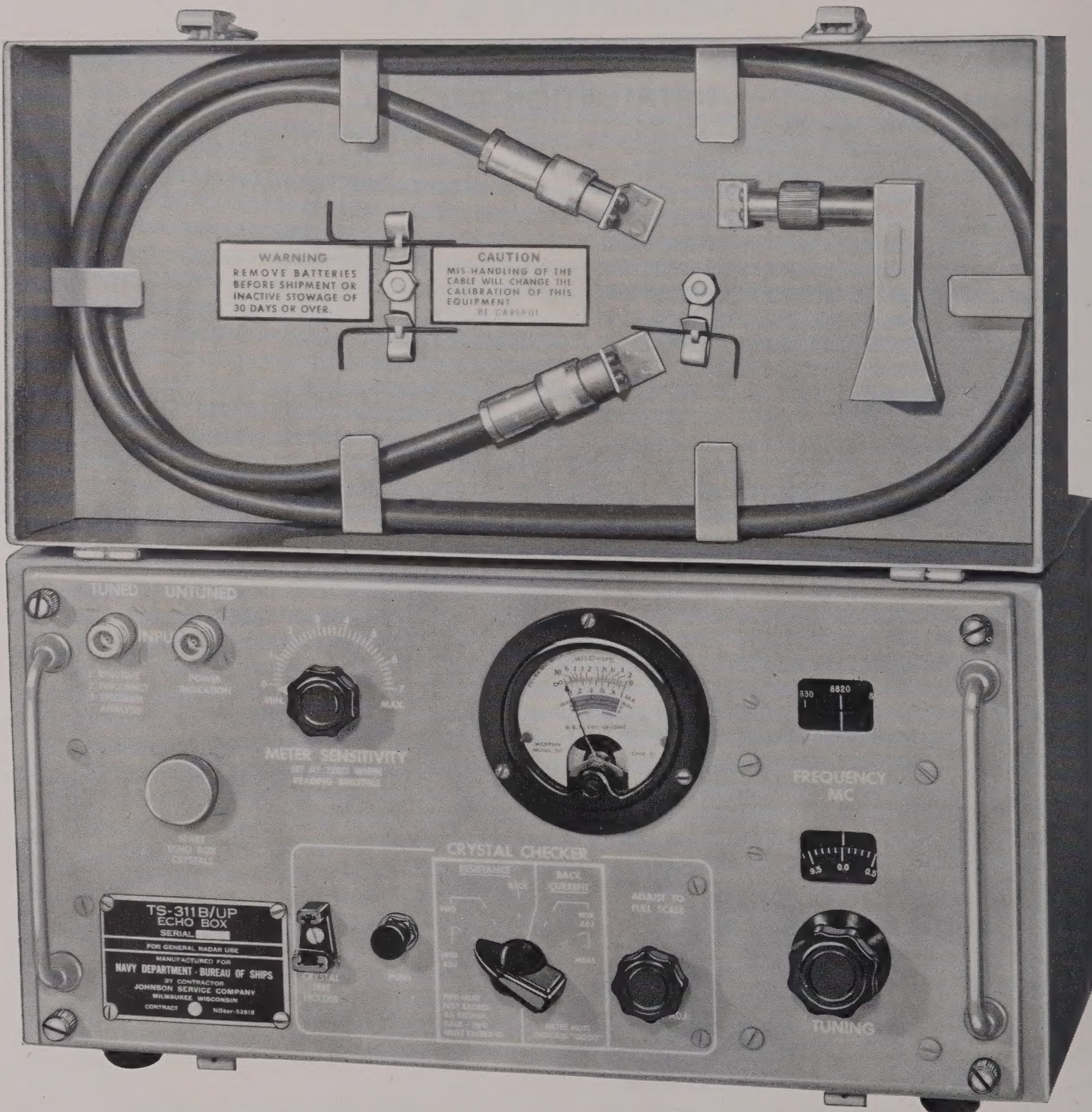

Figure 1-1. General View Echo Box TS-311B/UP

SECTION 1
GENERAL DESCRIPTION

CAUTION

Do not use Echo Box TS-311B/UP to test radars in which the R-F power and frequency are entirely unknown, or for which the test set is not designed. The meter and crystal are unprotected and excessive power applied to the input may damage the equipment. Although the instrument is designed to withstand shock and vibration normally met with in service, handle it carefully. Very rough handling may damage or change the characteristics of the equipment.

1. GENERAL DESCRIPTION

a. Echo Box TS-311B/UP is a ringing cavity designed to operate at frequencies between 8730 Mc. and 8910 Mc. It is a portable, self-contained instrument used to check the over-all performance of a radar set. It is powered by the R-F energy picked up from the radar set under test. A crystal checker unit is provided for testing rectifier crystals in the field.

b. The echo box is housed in a splashproof carrying case equipped with a removable cover. (See figure 1-1.) The top of the instrument serves as a panel on which are mounted a coaxial UNTUNED INPUT jack, a coaxial TUNED INPUT jack, a TUNING control, FREQUENCY dials, a METER SENSITIVITY adjustment, a resonance indicator meter, and the CRYSTAL CHECKER controls comprising a CRYSTAL TEST HOLDER, a push-button crystal checking switch, a rotary selector switch, and a METER ADJUSTMENT control. Inside the cover, provision is made for carrying a Pick-up Antenna AT-68/UP, and eight feet of Radio Frequency Cable RG-9A/U complete with fittings. The manually tuned resonant cavity, a smoothing capacitor, the input transducer and crystal unit assembly and the crystal checker network are mounted on the underside of the front panel.

2. PURPOSE

Echo Box TS-311B/UP can be used to make the following tests on radar sets operating within the frequency range of 8730 to 8910 Mc.

a. Over-all performance check of a radar. This is the primary purpose of the test set.

b. Comparative measurements of the power output of a radar transmitter.

c. Spectrum analysis of a radar transmitter.

d. Check for multiple moding of a radar transmitter.

e. Check for transmitter frequency pulling.

f. Check for the speed of recovery of a radar T-R box and receiver.

g. Test for performance of rectifying crystals in the 1N23, 1N21 and 1N25 series.

3. REFERENCE DATA

a. Nomenclature of all complete equipments involved — Echo Box TS-311B/UP.

b. Contract number and date — NObsr-52618, 20 June 1951.

c. Contractor — Johnson Service Company, Milwaukee, Wisconsin.

d. Cognizant Naval Inspector — Inspector of Naval Material, Milwaukee, Wisconsin.

e. Number of packages involved per complete shipment of equipment — 1.

f. Total cubical contents —
(1) Crated — 2.6 cubic feet.
(2) Uncrated — 2 cubic feet.

g. Total weight —
(1) Crated — 36 lbs.
(2) Uncrated — 23½ lbs.

h. Frequency range — 8730 Mc. to 8910 Mc.

i. Type —
(1) Tuned Input: Manually tuned Echo Box.
(2) Untuned Input: Antenna direct to crystal.
(3) Crystal checker: For testing 1N23 series crystals.

j. Frequency change with temperature does not exceed 0.14 Mc. per degree Centigrade.

k. Input Impedence — nominally 51 ohms.

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIP.	NAME OF UNIT	NAVY TYPE DESIGNATION	OVER-ALL DIMENSIONS			VOLUME	WEIGHT
			HEIGHT	WIDTH	DEPTH		
1	ECHO BOX	TS-311B/UP	11	16	8½	.867	19¼
1	PICK-UP ANTENNA	AT-68/UP	1⅛	2⅛	3⅜	.0047	.20
1	Cable (W-101)	CG-92B/U(8)				.015	1.
1	Rectifier Crystal	JAN-1N23B	27/32	19/64 max.dia.			
1	Allen Wrench No. 6						
1	Allen Wrench No. 8						
1	Allen Wrench No. 10						
2	Instruction Books	NAVSHIPS					

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NAVY TYPE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	1½V Dry Cell	JAN-BA2030/U	Operates crystal checker	

TABLE 1-3. SHIPPING DATA

SHIPPING BOX NO.	CONTENTS		OVER-ALL DIMENSIONS			VOLUME	WEIGHT
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
1	Echo Box	TS-311B/UP	13½	22	15¼	2.6	36

Unless otherwise stated, dimensions are inches, volume, cubic feet, weight pounds.

SECTION 2
THEORY OF OPERATION

1. MECHANICAL CONSTRUCTION

a. GENERAL — The general construction of the equipment is shown in figures 1-1 and 7-2. The functional schematic diagram is shown in figure 7-1.

b. RESONANT CAVITY.—The resonant cavity is a silver plated brass cylinder. At one end of the cylinder is a piston actuated by the tuning control, the other end is equipped with an adjustable plate which forms the end of the cavity. The position of the piston in the cavity determines the resonant frequency.

c. CRYSTAL RECTIFIER.—The crystal rectifier unit consists of a small piece of silicon and its spring contact mounted in a ceramic case, type 1N23, 1N23A, or 1N23B.

d. CRYSTAL CHECKER.—The circuit, battery, and switches of the CRYSTAL CHECKER are all mounted on the under-side of the panel. This unit provides a means of testing crystal rectifiers in the field with sufficient accuracy to determine whether or not they are satisfactory for use, by measurement of the forward and backward resistance and the back current at one volt. The schematic diagram of the crystal checker circuits are included on Figure 7-5.

e. INPUT.—The TUNED input jack is connected through a coaxial cable to a short section of wave-guide which provides coupling to the main cavity. The UNTUNED input jack is connected to the rectifier crystal through a coaxial cable and a short length of wave-guide that functions as an attenuator.

f. ADJUSTABLE COUPLING TO CRYSTAL.—The crystal rectifier and meter circuits are coupled to the main cavity by means of a transducer consisting of a short section of wave-guide mounted near the end of the cavity. The amount of R-F energy reaching the crystal is controlled by a vane that introduces an attenuation in the common transmission path. The vane is controlled by the METER SENSITIVITY knob on the front panel and affects both the tuned and untuned input.

2. ACTION OF RESONANT CAVITY

a. The electrical action of the resonant cavity can be compared with that of a low loss (high Q) resonant circuit, in which energy may be stored in the form of rapidly alternating electrical and magnetic fields. When energy is introduced into the cavity through the input circuit, oscillations persist until they are dissipated by losses within the cavity itself or energy fed back through the input circuit.

b. The circuit, as shown in figure 2-1, is basically equivalent to that shown in figure 2-2. The resonant cavity is coupled to the antenna by means of the input circuit, in much the same way as the lumped resonant circuit is coupled to its antenna by the mutual inductance between its coil and the antenna coil. The frequency at which the cavity is resonant is varied by moving the piston in or out. The frequency of the L-C circuit is varied by changing the amount of inductance or capacitance or both. In either case, maximum energy is stored in the cavity or L-C circuit when they are tuned to the incoming wave.

c. When the antenna is placed in the beam of a radar set, some R-F energy is picked up and fed into the echo box cavity. The cavity starts oscillating with the oscil-

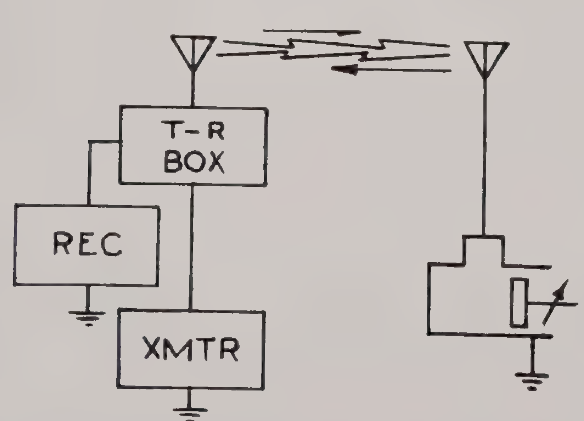

Figure 2-1. Radar and Tuned Ringing Cavity

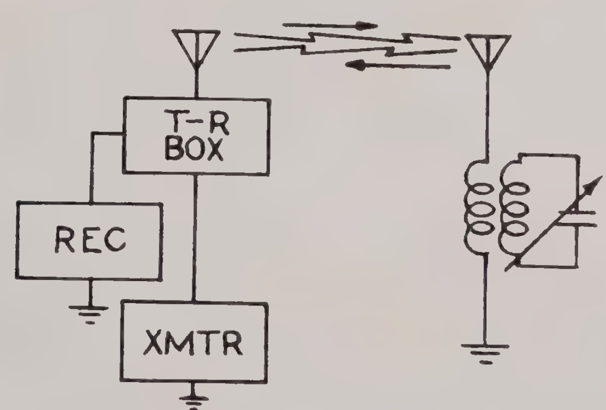

Figure 2-2. Radar and Equivalent Lumped L-C Circuit

lations as shown in figure 2-3. The oscillations in the cavity die out gradually after the radar pulse has ended. During this interval, part of the stored energy is dissipated in the cavity itself, and part is re-radiated from the echo box antenna. Some of the re-radiated energy is picked up by the radar antenna, and passed to the radar receiver where it causes a trace on the radar indicator. During this period the cavity is said to be ringing. The length of time of the ringing period is known as ring-time, and is measured from the beginning of the radar pulse to the end of the signal sent back from the cavity. The signal is considered to be at an end when its amplitude is down to the level where it disappears into the receiver noise background. For convenience, figure 2-3 shows only a few cycles of oscillation during both the radar pulse interval and the ringtime interval. Actually the radar pulse extends over approximately 2000 cycles, and the ringtime over about 250,000 cycles for a typical radar system.

d. In the design and construction of the resonant cavity, every effort is made to keep internal losses at a minimum, therefore the Q is very high (approximately 70,000). The Q of a resonant circuit using lumped inductance and capacitance is seldom greater than 800 to 1000, even under favorable conditions. This high Q explains why oscillations continue to build up throughout the duration of the R-F pulse received from the radar, because the higher the Q of a circuit the slower it builds up to maximum response. It also enables the cavity to continue oscillating for a comparatively long time after the incoming pulse has ceased.

e. The length of the ringing time is determined by the power of the transmitter and the sensitivity of the radar receiver, so that the longer the ringing time the better the performance of the radar. The echo box will ring about 4000 to 5000 yards, but the amount of the ringing time depends on the radar and on how the echo box is coupled to the radar. Section 4 OPERATION gives instructions on how to predict how long the echo box should ring. The performance of the radar is then judged by comparing the ringing time measured to this predicted value. The echo box can also be used by comparing the ringing time obtained when the radar is known to be in good shape, to that ringing time obtained on a particular test.

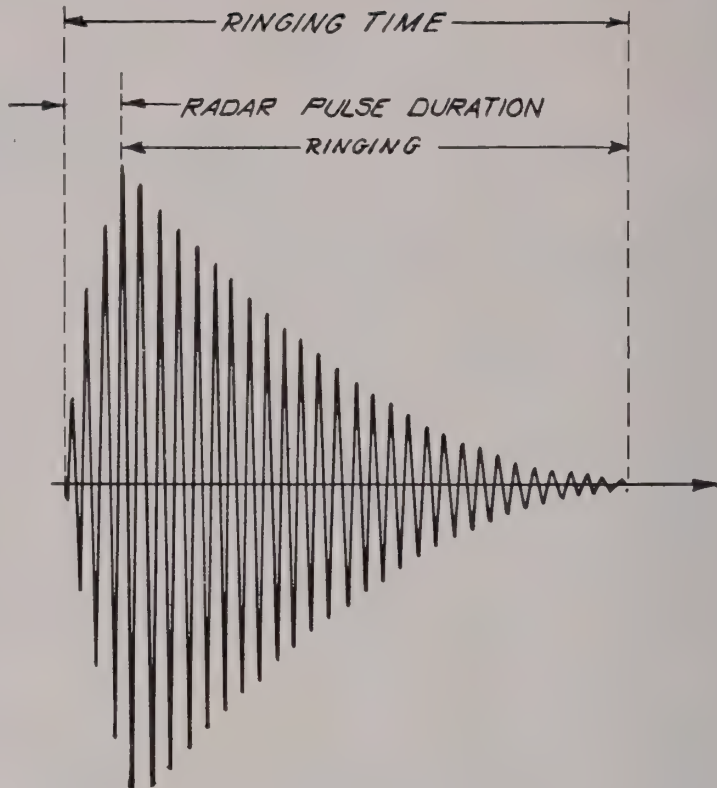

Figure 2-3. Relation of Radar Pulse and Ringtime

f. The echo box crystal rectifier, CR-101 in figure 7-1, rectifies the R-F energy entering the crystal assembly. The amount of energy rectified by the crystal is indicated on the meter M-101. Capacitor C-101 causes the meter circuit to have a low impendance to the rectified pulse from the crystal. The crystal rectifier unit and circuit are so designed, that the meter indication is approximately proportional to the amount of R-F energy arriving at the crystal rectifier.

g. An untuned input is provided so that a check for the presence of R-F energy can be made without tuning the echo box. This circuit feeds energy from the untuned input jack through a fixed antennuator, then through a variable attenuator (Meter Sensitivity Control) to the crystal. This input should not be used in radar performance measurements.

SECTION 3
INSTALLATION

1. UNPACKING

Exercise particular care when unpacking the Echo Box TS-311B/UP particularly when prying off the top of the wooden packing case. After the instrument has been unwrapped, check the items against Table 1-1. Inspect the equipment thoroughly for possible damage during shipment.

2. INSTALLATION

a. Echo Box TS-311B/UP is a portable instrument, therefore it may be located in any position convenient for operation where the connecting cable will reach the R-F pickup connection.

b. The echo box is connected to the radar directional coupler if a directional coupler is provided. In the event that a directional coupler is not provided, the pick-up antenna AT-68/UP which is provided can be placed in front of the radar antenna as a substitute. This is covered in Section 4, OPERATION.

c. Eight feet of Radio Frequency Cable RG-9A/U (W-101) is supplied with the equipment. It is not advisable to use a longer or shorter length of cable.

d. Install a flashlight cell in the battery holder BT-101 as directed in Section 5 paragraph 1-c. A 1½ volt cell, JAN-BA2030/U or equivalent is required.

3. INITIAL ADJUSTMENT

The only initial adjustment is the zero setting screw on the face of the meter. If the meter needle does not line up with the zero on the scale, turn the adjustment screw to the right or left slightly until the meter does indicate zero. This adjustment should be made with the instrument in its normal operating position, and with no power applied.

4. REPLACING CABLE CONNECTORS

The detailed procedure to be used in replacing connectors is illustrated in figure 3-2. To ensure correct results, follow this procedure exactly, and step by step:

One—Cut back the vinylite jacket square and even as shown.

Two—Push back braid and cut off ¼ inch of cable dielectric.

Three—Pull braid forward and taper toward center conductor.

Four—Insert cable into clamping nut (1), thin metal washer (2), rubber washer (3), and clamping sleeve (4) in order as indicated. Be sure that clamping sleeve (4) clears all braid wires and its internal shoulder rests squarely against end of vinylite jacket.

Five—Unbraid shield wires, spread open and lay back on clamping sleeve (4) without wires crossing each other. Cut off excess braid wire length so that each wire will end before touching shoulder of clamping sleeve (4).

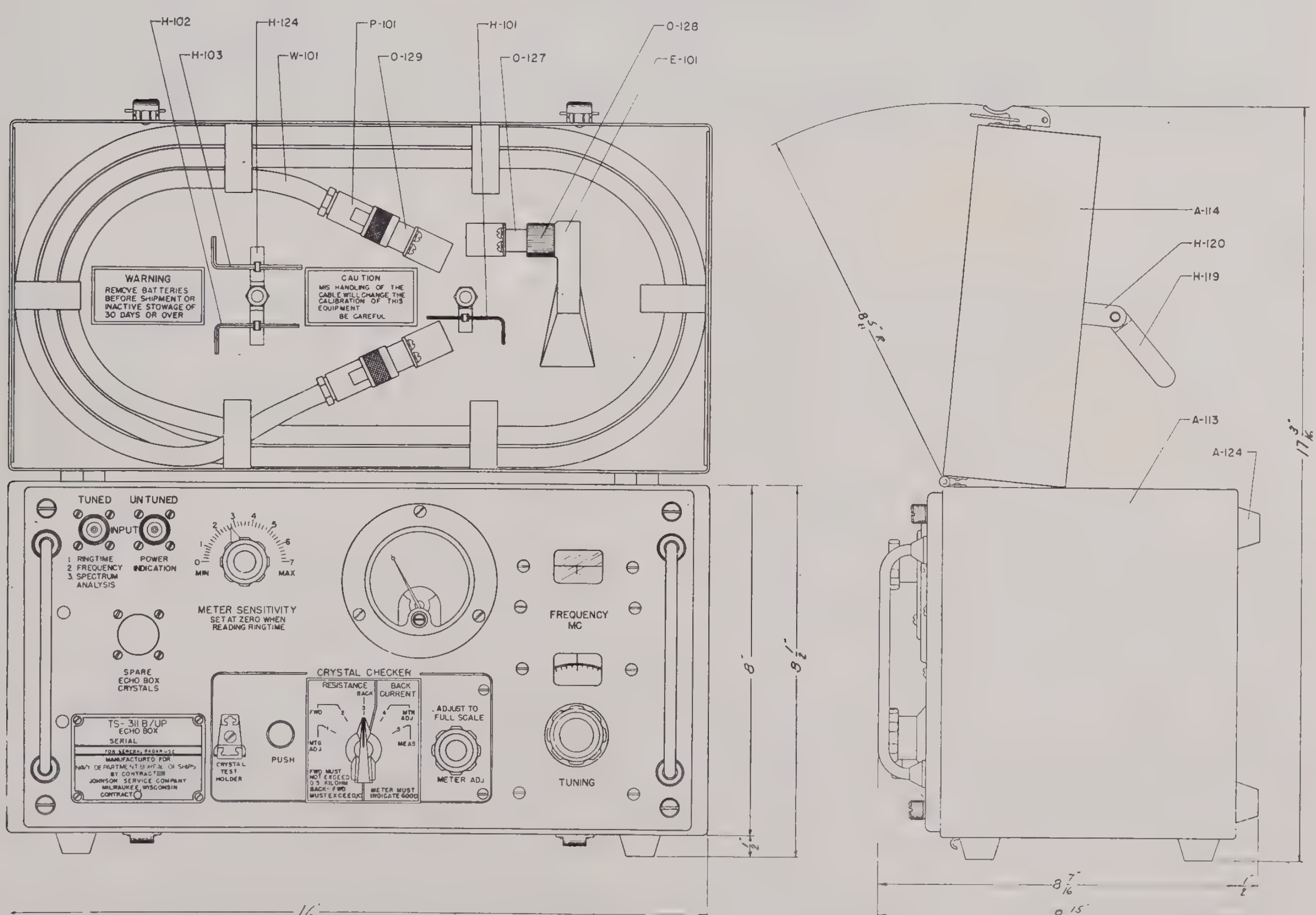

Figure 3-1. Outline and Dimensional Drawing of Echo Box TS-311B/UP

Cut off cable dielectric 5/32″ from end of braid wires. Be sure to cut square and even and do not nick center conductor. Cut center conductor 3/16″ from end of cable dielectric and tin. Solder male contact carefully and remove excess solder. Be careful that solder or flux does not get on end of cable dielectric.

Six—Insert cable into plug as far as it will go. Push rubber washer (3) and thin metal washer (2) into body and tighten clamping nut (1). Hold body with wrench and tighten clamping nut (1). Do not allow body or cable to rotate during this operation.

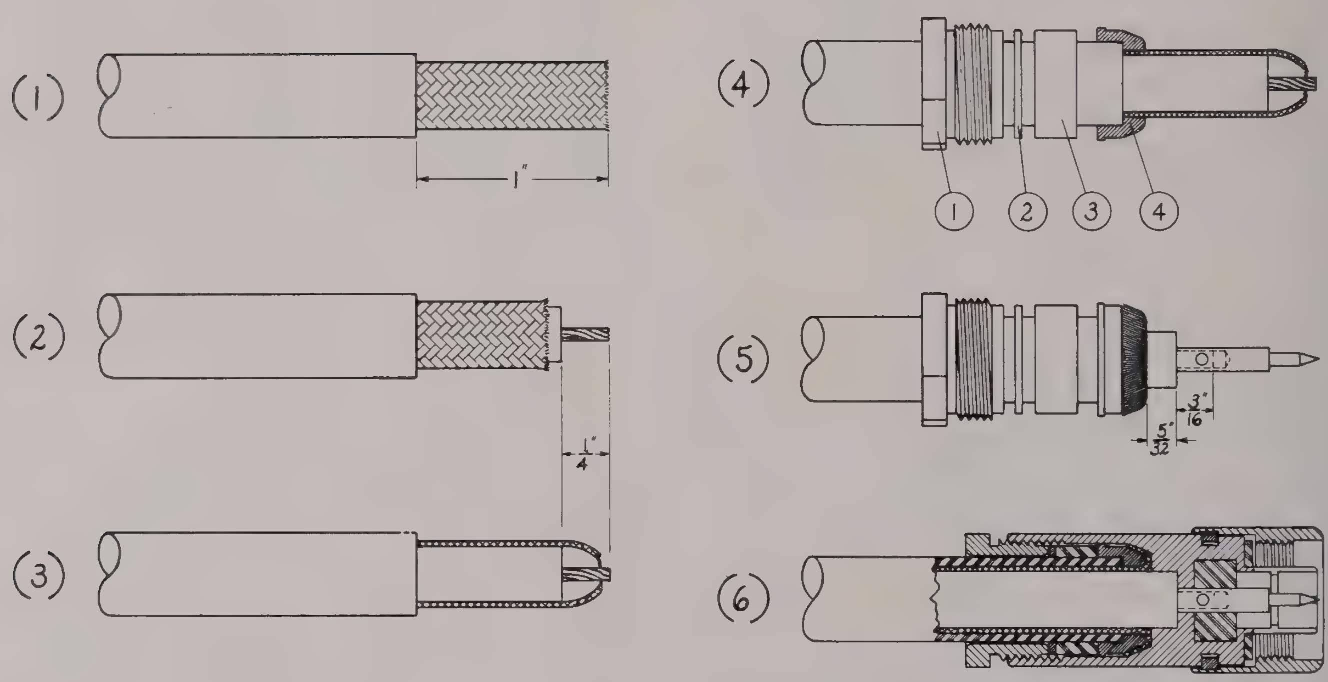

Figure3-2. Attaching Connectors UG-21B/U to Cables RG-9A/U

SECTION 4
OPERATION

Figure 4-1. Front Panel Echo Box TS-311B/UP

1. GENERAL

Echo Box TS-311B/UP is a ringing cavity designed to operate between 8730 Mc. and 8910 Mc. It is a portable and self-contained instrument used to check the over-all performance of a radar set. The echo box is powered by R-F energy picked up from the radar set under test. A crystal checking unit is included for field check of crystals in the IN23 series.

2. COUPLING THE ECHO BOX TO THE RADAR

The echo box may be coupled to the radar by means of the pick-up antenna furnished, or by means of the radar directional coupler.

a. USE OF THE PICK-UP ANTENNA—The equipment is supplied with a pickup horn (Pick-up Antenna AT-68/UP) and antenna cable W-101. A general rule is to locate the pick-up horn so that it is directed towards the antenna of the radar set under test and out from the coaxial or wave-guide feed by a distance equal to the largest dimension of the radar reflector. The horn should be oriented to get maximum pick-up. This location may be found by trial and error, and should be used in all tests on the same set so that the results will be uniformly comparable. The pick-up horn receives energy through the open face, and is polarized in the direction of the attached cable. The direction of polarization of the pick-up horn must be adjusted to match that of the type of radar being tested. The "Untuned" input to the echo box can be used to indicate when the orientation is correctly adjusted. The meter will give maximum reading when the correct polarization is obtained. Use the "Meter Sensitivity" control to prevent the meter from going off scale if necessary. Ordinarily, the pick-up horn should be fastened by any convenient means to some object capable of giving it solid support. No specific directions can be given for this installation as there are many different radar types and installations. Under some conditions the horn may be held in the hand, but this is definitely not recommended because erratic readings will be produced if the horn is not held steady. In general, the directional coupler method is far preferable and as a method of coupling, the pick-up horn should be used only as a last resort.

b. DIRECTIONAL COUPLER METHOD. — Most

radar systems are equipped with a directional coupler through which R-F energy can be taken from the radar wave-guide for test purposes. If the directional coupler has a coupling of between 20 and 26 db, it will be well suited for ringtime observation. In this case the connecting cable furnished with the echo box is employed to connect the two units together. The pick-up antenna should of course not be used.

Note

THE PICK-UP LOSSES OF DIRECTIONAL COUPLER WILL BE FOUND MARKED ON THE COUPLER ITSELF.

3. FRONT PANEL CONTROLS

There are two controls, an UNTUNED INPUT jack and a TUNED INPUT jack, and a REASONANCE INDICATOR on the front panel of the Echo Box TS-311B-/UP. (See figure 4-1).

a. TUNING CONTROL.—The tuning control, together with the dial which is calibrated in megacycles, actuates a piston which changes the length of the cavity, thus changing the resonant frequency of the cavity. The top dial is calibrated in 10 megacycle steps. The bottom dial indicates finer divisions of frequency. For instance; — set the top dial to 9000 and the bottom dial to 0.0. The echo box will be tuned to 9000 megacycles. If the bottom dial is now rotated counter-clockwise until it reads 3.5, the echo box will be tuned to 9003.5 megacycles.

b. METER SENSITIVITY CONTROL.—On zero, this control applies maximum attenuation between the cavity, or the Untuned Input, and the crystal. On "10", the attenuation is least and therefore the meter sensitivity is maximum.

CAUTION

After completing a test, always leave the meter sensitivity control at zero, and when first making a test advance the control slowly, thus reducing the danger of burning out the echo box crystal.

c. TUNED INPUT JACK.—The TUNED INPUT jack couples the power from the RG-9A/U cable to the cavity.

d. UNTUNED INPUT JACK.—The UNTUNED INPUT jack couples the power directly into the crystal wave-guide.

e. RESONANCE INDICATOR.—The RESONANCE INDICATOR shows the amount of power rectified by the crystal. This indication is roughly proportional to the amount of power applied to the crystal.

f. CRYSTAL CHECKING SWITCH.—The "PUSH" Crystal Checking Switch and Rotary Selector Switch connect the crystal checking resistance network to the resonance indicator for use as a crystal checking meter.

4. GENERAL OPERATING PROCEDURE

a. RADAR PERFORMANCE RECORDS.—Keep a performance record of every radar installation, showing the results of each test. Such a record serves as a life history and tends to show any progressive deterioration in performance. It is a useful guide in locating defective apparatus or improper adjustment in the radar system. Figure 4-2 is a sample of such records. Several blank sheets for this purpose are included in the back of this book.

b. INTERCHANGE OF COMPONENTS.—The performance of individual echo boxes will vary in both ringtime and power readings. Once a record of measurements has been made with a given echo box and its accessories, keep the unit together. If any part, such as cables, etc., are interchanged or replaced, check the operation of the echo box against previous measurements, and if necessary make a new record with this combination.

5. OVER-ALL PERFORMANCE TEST OF RADAR

The following instructions assume that a directional coupler is to be used. When using the pick-up dipole locate the dipole in standard position as indicated in 2a above.

a. PRELIMINARY PROCEDURES

(1) Place the radar equipment in operation and allow it to warm up to its normal operating temperature.

(2) Check to be sure that the radar antenna is not pointed toward nearby reflecting surfaces, such as the mast of a ship, which might cause the transmitter frequency to be "pulled".

(3) Connect the TUNED input of echo box to the directional coupler of the radar by means of the eight foot cable furnished.

(4) Tune the echo box to the frequency of the transmitter by use of the TUNING control. If the approximate transmitter frequency is known this may be used as a rough guide. The echo box is tuned to the correct frequency when the meter reading is at a maximum. The METER SENSITIVITY control should be set at about three if the meter reading to be expected with the particular type of radar is not known in advance. It is a good idea to tune carefully so that the meter will not suddenly go off scale when the correct frequency is reached. Keep the meter on scale by use of the METER SENSITIVITY control. On each side of the correct frequency there are to be found small peaks in the meter reading. Be careful to get the main peak and not one of these smaller peaks.

RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ______________ SERIAL ______________ LOCATION ______________

ECHO BOX TS-311B/UP, SERIAL ______________ RADAR CONDITIONS:- PULSE LENGTH ______

TESTS MADE:- WITH DIRECTIONAL COUPLER ______________ REP. RATE ______

WITH TEST ANTENNA ______________ REC. BW. ______

LOCATION ______________ RINGTIME ______

DATE	TIME	OBSERVED RINGTIME	RADAR PERFORMANCE	RADAR METERS		CHECKED BY
				CRYSTAL CURRENT	TRANSMITTER CURRENT	
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
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		YDS.	DB. DOWN			

Figure 4-2. Radar Performance Check Sheet

CAUTION

During this test be very careful not to damage the crystal or meter. The meter should not be allowed to go off scale. Keep the needle below a reading of .8 MA.

(5) Turn off any anti-jamming circuits and the sensitivity time control if provided on the radar.

(6) Check the calibration of the accurate ranging circuit of the radar if provided.

(7) Point the antenna of the radar so that a clear place at short range is obtained on the indicator, clear of nearby echoes, so that the ringing time can be seen clearly. It may be helpful to point the radar antenna upward if this is possible.

(8) Tune the radar local oscillator, if automatic frequency control is not in use, so the exactly maximum ringing time is seen on the radar indicator.

(9) Adjust the IF gain control of the radar until the noise is at about one third of the highest signal level. In the event that this "grass" cannot be seen the gain of the radar IF amplifier is inadequate and it should be repaired.

(10) Radar sets have a tendency to drift in frequency. Check to see that the echo box is still in exact tune, then turn the METER SENSITIVITY control to zero and read the ringing time as directed below.

b. MEASUREMENT OF RINGTIME ON AN A-SCOPE

(1) The appearance of a typical ringing time is illustrated in figure 4-3. The ringing time to be measured, in units of radar range, to the last point at which a trace of the ringing can be seen. Do not judge ringtime by the bottom of the grass nor by the end of the saturated top portion, as these are influenced by the receiver gain setting and by other factors.

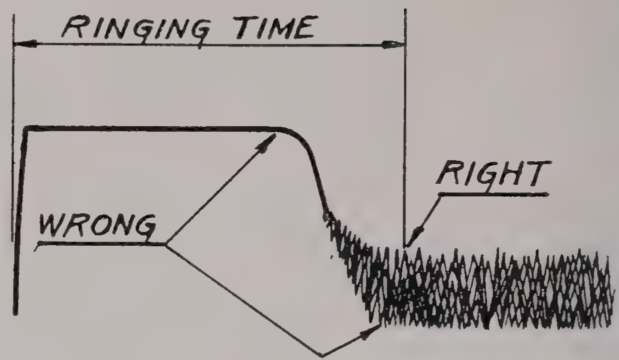


Figure 4-3. Ring-time Patterns, A-Scope

(2) Repeat each ringtime measurement on an A-scope at least four times and average the result, since there is an element of judgment involved and this method will reduce the error. Practice is very important in reading ringing time. With practice one can detect the weak end of the ringing time which runs out into the grass.

The operator who obtains the greatest ringing time measurement is usually the most nearly correct.

(3) Ringing time measurements should be recorded to the nearest fifty yards. It is convenient to read them to the nearest ten yards before averaging. Individual measurements made with care will not disagree more than one or two hundred yards, and the average is more accurate than this.

Using a Directional Coupler

Using a Fixed Dipole

Figure 4-4. Ringing Time Patterns on a PPI

Figure 4-5. Ringing Time Pattern on a PPI with Antenna Stopped

c. MEASURING RINGING TIME ON PPI.—If it is not possible to use an A-scope for the measurement of the ringing time, a somewhat less accurate measurement may still be made with the PPI. The same general principles apply. The following standard procedure should be followed:

(1) With the radar antenna in rotation, set the receiver gain at a minimum and adjust the intensity (bias) so that there is a very slight radial trace on the PPI indicator.

(2) Increase receiver gain until the PPI indicator area seems to be just half covered with flecks of "snow".

(3) Good PPI ringing-time patterns, with proper receiver gain adjustment (and with radar antenna rotating) are shown in figure 4-4. The PPI pattern shown is that which result when the echo box is used with a directional coupler, or when the echo box is used with a pick-up dipole and both the echo box and dipole rotate with the radar antenna.

(4) If the radar antenna is stopped (for convenience in tuning the radar), the PPI ringing-time pattern will be brighter, but more difficult to read correctly. With the radar antenna stopped, the PPI ringing-time pattern will have the general appearance illustrated in figure 4-5.

(5) It should be remembered that the end of a ringing-time signal is NOT at the place where the bright or saturated part of the signal ends, but where the fainter portion of the signal disappears into the background noise. Therefore, when reading ringing time on a class PPI indicator, be sure to observe to the extreme tip of the pattern, and NOT JUST TO THE END OF THE BRIGHT PORTION of the pattern. Read to the last point at which the "snow" is unusually bright.

d. INTERPRETING RINGTIME MEASUREMENTS

If one knows how long the echo box should ring under the particular conditions of the test (this is called the "expected ringing time") one may compare the ringing time observed with the expected ringing time to determine whether the radar is performing well.

The ringing time to be expected in testing under given conditions can be set down in advance, as indicated in the following paragraphs. The ringing time to be expected on a good radar depends on the particular type of radar being tested; on the way in which the echo box is installed, that is for example, upon the coupling of the directional coupler used and upon the length and kind of cable that is used; on the individual ringing ability of the particular echo box employed; on the frequency of the radar; and on the temperature of the echo box at the time of the test. Corrections are made for all of these factors in the following procedures:

Alternately, the expected ringing time can be learned by experience for a particular type of radar with the echo box used in a particular way. The best ringing time obtained when the set is believed to be operating at best performance is recorded as the expected ringing time. Under most conditions satisfactory results will be had by this method, but it is better to predict the ringing time in the way shown below if this can be done. In some cases, particularly when the pick-up antenna is used with the echo box, it will be necessary to find the expected ringing time by experience.

The first step in predicting ringing time is to figure the "uncorrected ringing time" for the particular radar and the way that the echo box is connected to it. This number is the same for all radars of this type and for any serial number of TS-311B/UP echo box. Having found this "uncorrected ringing time", one must correct it for the particular echo box and for the temperature at which the test was made, if this temperature is either very cold or very hot.

(1) HOW TO FIND THE UNCORRECTED RINGING TIME

To find the uncorrected ringing time first go to the radar manual and find these facts about the radar:

(a) how long is the radar pulse, in microseconds.

(b) what is the power of the radar pulse, in kilowatts.

(c) what is the bandwidth of the receiver, in megacycles.

(d) what is the "coupling" of the directional coupler. (this value should be marked on the directional coupler itself). This value is on decibels.

(e) the attenuation of the echo box cable. This cable is furnished with the echo box, and unless some other cable is used the attenuation is 5 decibels.

The uncorrected ringing time can be found by substituting these numbers in the formula below, or it can be found with the nomogram type chart, Fig. 4-6 without using algebra. The result is exactly the same, but some users may prefer one method and some the other so both are given. In the event that two different pulse lengths and perhaps two different receiver bandwidths can be used on the radar, calculate an uncorrected ringing time for each condition.

(2) FORMULA FOR THE UNCORRECTED RINGING TIME.

Uncorrected ringing time

$$= 7800 + 60 \left[\log_{10} \frac{Pt^2}{B} - 2 \right] + 164t$$

Where:

R=Uncorrected ringing time, in yards, for a good radar.
P=power of transmitter pulse, in kilowatts.
t=transmitter pulse length, in microseconds.
B=receiver band width, in megacycles.
A=attenuation between echo box and radar, in decibels. This value is the sum of the attenuation of the cable and the coupling of the directional coupler, both expressed in decibels.

Sample calculation:

Suppose we have a radar with a transmitter having 50 KW pulse power, a one quarter microsecond pulse, a receiver with a six megacycle pass band, and a directional coupler having twenty decibels coupling. The standard echo box cable, having an attenuation of 5 decibels, is to be used. Thus $P=50$, $t=\frac{1}{4}$, $B=6$, and $A=20+5$ or 25.

The formula gives: Uncorrected ringing time

$$=7800+60 \left[10 \log_{10} \frac{(50 \cdot \frac{1}{4}^2)}{6} - 2.25 \right] + 164 \cdot \tfrac{1}{4}$$

$$=7800+60 \left[10 \log_{10} .52 - 50 \right] + 41$$

$$=7800+60 \left[-2.8 - 50 \right] + 41$$

$$=7800 - 168 - 3000 + 41$$

$$=7800 - 3168 + 41$$

=4673 yards, or about 4670 yards

(3) CHART FOR FINDING THE UNCORRECTED RINGING TIME.

Figure 4-6 is a nomogram type chart for finding the uncorrected ringing time. Instructions for using it appear on the chart. Correct the uncorrected ringing time, whether found by the formula or by the chart, to get the expected Ringing Time, as described below.

(4) FINDING THE EXPECTED RINGING TIME.

The individual TS-311B/UP echo boxes vary slightly in their ringing ability.

One echo box at the factory is set aside as a standard, and each echo box made is compared to this standard. A number is marked on each echo box which indicates the ringing ability of the box relative to the factory standard. This number is found stamped on the meter glass. A typical marking of this sort might read +6%. This means that at the factory test this echo box rang six percent more than the factory standard. The uncorrected ringing time should be increased by 6% to allow for this.

In addition tests may be made in the field under conditions of temperature which vary widely from the standard temperature. The effect of temperature is small, but the ringing time is slightly increased if the echo box is very cold and decreased if the temperature is very warm. This is because the silver surface of the echo box changes in resistance just like any metal changes resistance with temperature. A good rule of thumb is that the echo box rings one percent more for each ten degrees Fahrenheit that the box is cooled from room temperature (70°F.), and rings one percent less for each ten degrees that it is warmed above room temperature. Example: The test is being made in the sun on a hot day, and the echo box is about 120°F. This is about fifty degrees above room temperature (70°F.) so the echo box should ring five percent less than it would at room temperature. Table 4-1 shows the effect of echo box temperature on ringing time. This echo box has almost the same ringing time at any frequency within the band, so that no correction needs to be made for the tuning of the echo box.

It is sufficiently accurate to add the corrections and apply the total correction.

Example:

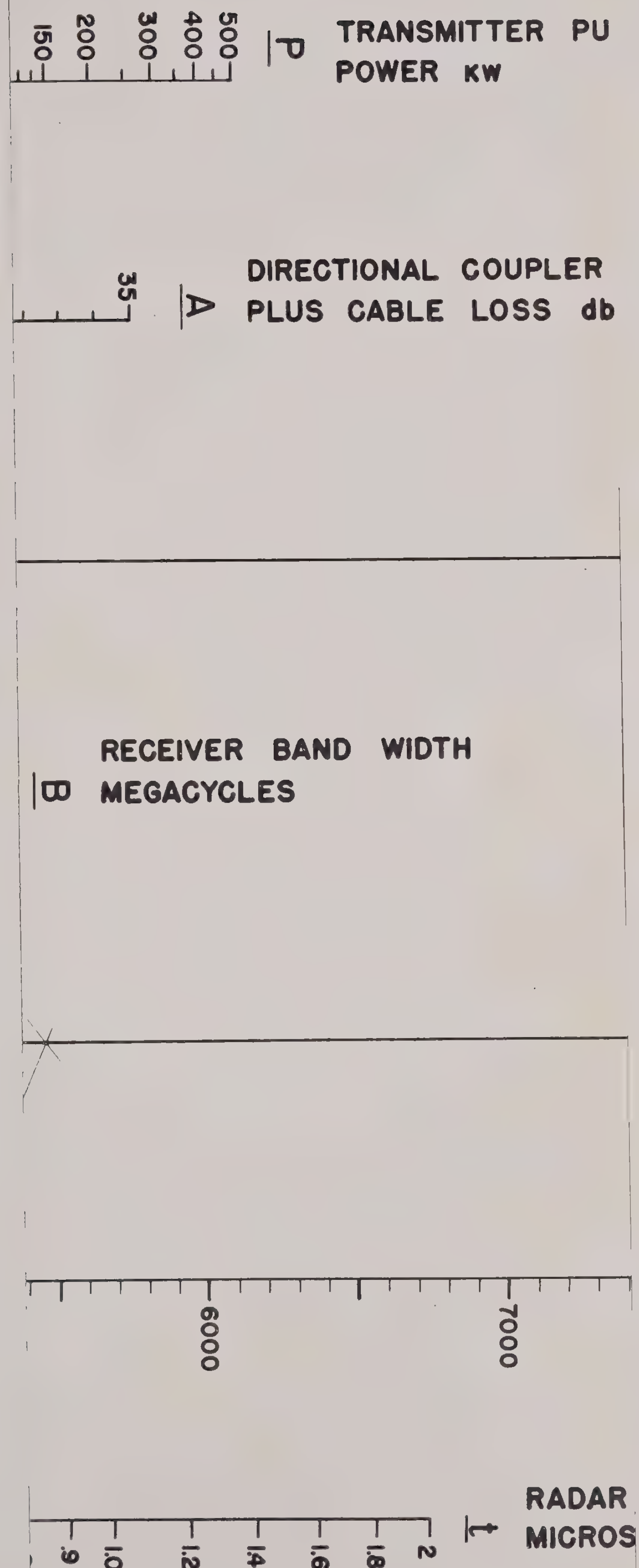
Correction marked on box	+6%
Correction for temperature	−5%
Total correction	+1%
Uncorrected ringing time	4670 yards
Add 1% of 4670	47
	4717 yards

This is the expected ringing time.

The expected ringing time will not change enough to matter unless the temperature changes, and a rather large temperature change would be necessary to change the value very much. This means that a new value need not be figured each time the echo box is used.

(5) RADAR PERFORMANCE MEASUREMENT

The expected Ringing time is the ringing time that would be had if the radar were operating satisfactorily. The difference between the ringing time measured and the expected ringing time tells how well the radar is working.



ging Time Echo Box TS-311B/UP

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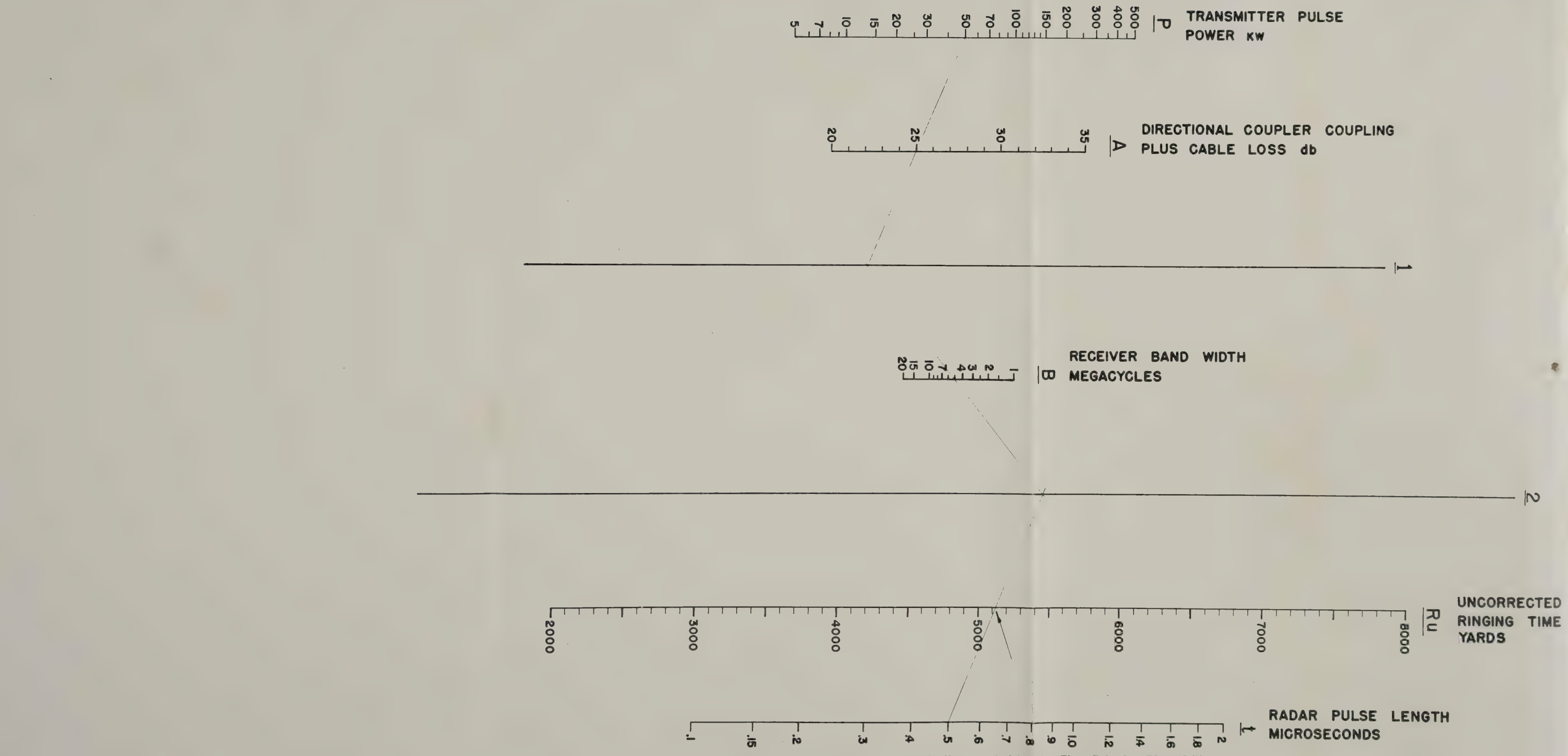


Figure 4-6. Nomogram for Finding the Uncorrected Ringing Time Echo Box TS-311B/UP

INSTRUCTIONS FOR FINDING THE UNCORRECTED RINGING TIME WITH THIS CHART:

1. Look in the radar manual for the power of the r-f radar pulse transmitted, in K.W. Mark this on the line "P".
2. Look on the directional coupler (or in the radar manual) for the "coupling" of the directional coupler, in decibels. Add to this the cable loss, in decibels. (The standard 8 foot RG-9A/U cable supplied has a loss of 5 decibels.) Mark this total on line "A".
3. Connect the mark on line P to the mark on line A with a sharp pencil and a ruler. Extend the line to reach line "1".
4. Look in the radar manual for the receiver band width, in megacycles. Mark this on the line B.
5. Connect the point where the first pencil line crossed line "1" to the point marked on line B and extend to line "2".
6. Look in the radar manual for the transmitter pulse length, in microseconds, or measure pulse length with echo box as in Section 4-7b(5). Mark this value on line "t".
7. Connect the point where the second pencil line crossed line "2" to the marked point on line "t".
8. Read the "Uncorrected ringing time" from where the third pencil line crosses the line "Ru", in yards. This is how much a standard box (marked "0%" on the meter glass) would ring at ordinary temperatures (70°F). To correct this value for temperature and the ringing ability of the particular box see section 4-5d (4) of this manual.

EXAMPLE:

Assume the radar puts out an R-f pulse of 50 kilowatts, has a 20 db directional coupler used with the standard 5 db echo box cable. Assume the receiver pass band is 5 megacycles, and that the pulse length is ½ microsecond. Draw the three lines shown, working from left to right. The uncorrected ringing time is 5120 yards as indicated by the arrow.

EXAMPLE:

Expected ringing time	4717 yards
Measured ringing time	4150 yards
	567 yards short

The echo box loses sixty yards of ring for every decibel of radar performance lost, thus the radar is $\frac{567}{60}$, or between nine and ten decibels down in performance. This is as though the transmitter were operating at one-tenth of the proper power output or the receiver at one-tenth proper sensitivity.

TABLE 4-1. EFFECT OF ECHO BOX TEMPERATURE ON RINGING TIME

TEMPERATURE	CHANGE IN RINGING TIME	TEMPERATURE	CHANGE IN RINGING TIME
−40° C (−40° F)	+13.7%	+20° C (+ 68° F)	+0.0%
−30° C (−22° F)	+10.8%	+30° C (+ 86° F)	−1.8%
−20° C (− 4° F)	+ 8.3%	+40° C (+104° F)	−3.6%
−10° C (+14° F)	+ 6.0%	+50° C (+122° F)	−5.2%
0° C (+32° F)	+ 3.9%	+60° C (+140° F)	−6.7%
+10° C (+50° F)	+ 2.0%		

The range of the radar would be seriously reduced.

Table 4-2 shows the behavior of ship-bourne radars with reduced performance. These are actual experimental data. Tests conducted during World War II showed that very many radars in use were operating far below their proper performance. Similar tests conducted since then have shown the same. Regular use of the echo box will detect reduced radar performance and permit this situation to be corrected.

(6) USUAL CAUSES OF POOR RADAR PERFORMANCE.

The radar transmitter is not the usual cause of radar performance troubles. Most troubles which cause seriously reduced transmitter power output will show up in obvious symptoms such as arcing in the radar lines or improper readings on the transmitter meters.

The usual causes of radar performance faults lie in the radar receiver. Troubles here are not indicated in an obvious fashion unless echo box or other performance tests are made. Low ring time with satisfactory power output observed on the echo box meter, indicates probable trouble in the radar receiver. Reduction of radar receiver sensitivity may be caused by:

(a) Loss of signal before the crystal rectifier by mis-tuned or defective components, or transmission line.

(b) Impaired gain of the crystal rectifier proper, as by reduced local oscillator power applied, or because of a defective crystal.

(c) Excessive noise in the crystal rectifier which would tend to conceal signal, due to a bad crystal or to excessive local oscillator power applied.

(d) Mis-match between the crystal rectifier and the first I-F stage which would cause a loss of signal power.

(e) Excessive noise in the first or second I-F tube.

(f) Excessive noise in the local oscillator due to improper tuning or a bad tube.

Trouble, other than reduced gain causing loss of

TABLE 4-2. RINGING TIME, RADAR PERFORMANCE, AND RADAR RANGE

LOSS IN RINGING TIME IN YARDS	SYSTEM DOWN IN DB	PERCENTAGE OF MAXIMUM RANGE AVAILABLE		
		AIRCRAFT	PERISCOPE	CRUISER
90 yards	1½ db	91%	94%	98%
180 yards	3 db	84%	88%	97%
300 yards	5 db	76%	82%	95%
600 yards	10 db	58%	69%	90%
900 yards	15 db	42%	58%	84%
1200 yards	20 db	31%	49%	78%
1500 yards	25 db	24%	40%	71%
1800 yards	30 db	18%	34%	62%
2100 yards	35 db	14%	28%	53%
2400 yards	40 db	10%	24%	45%
2700 yards	45 db	8%	20%	34%
3000 yards	50 db	6%	16%	21%

grass or snow, in IF stages beyond the second, does not affect radar performance.

It is not advisable to alter these tuning adjustments.

CAUTION

Since the echo box radiates on an extremely narrow frequency band as compared with the spectrum of the transmitter, it can be disastrous to attempt any tuning of the receiver I-F stages by means of an echo from the echo box. If such tuning is attempted, the receiver bandwidth may be narrowed and the ringtime will then increase, thus indicating apparently improved radar performance. On the contrary such I-F tuning will have actually impaired the operation of the radar set.

Note

THE ECHO BOX MAY BE USED TO MAKE A COMPARISON CHECK OF CRYSTAL RECTIFIERS. TUNE THE ECHO BOX TO RESONANCE WITH THE RADAR SET AND LEAVE IT ON FREQUENCY. PLACE EACH CRYSTAL RECTIFIER, IN TURN, IN THE RADAR SET AND WITH THE CRYSTAL CURRENT SET TO STANDARD VALUE, MEASURE THE RINGTIME. A COMPARISON OF THE RINGTIMES WILL GIVE AN INDEX OF THE RELATIVE MERIT OF THE CRYSTAL RECTIFIERS THUS TESTED.

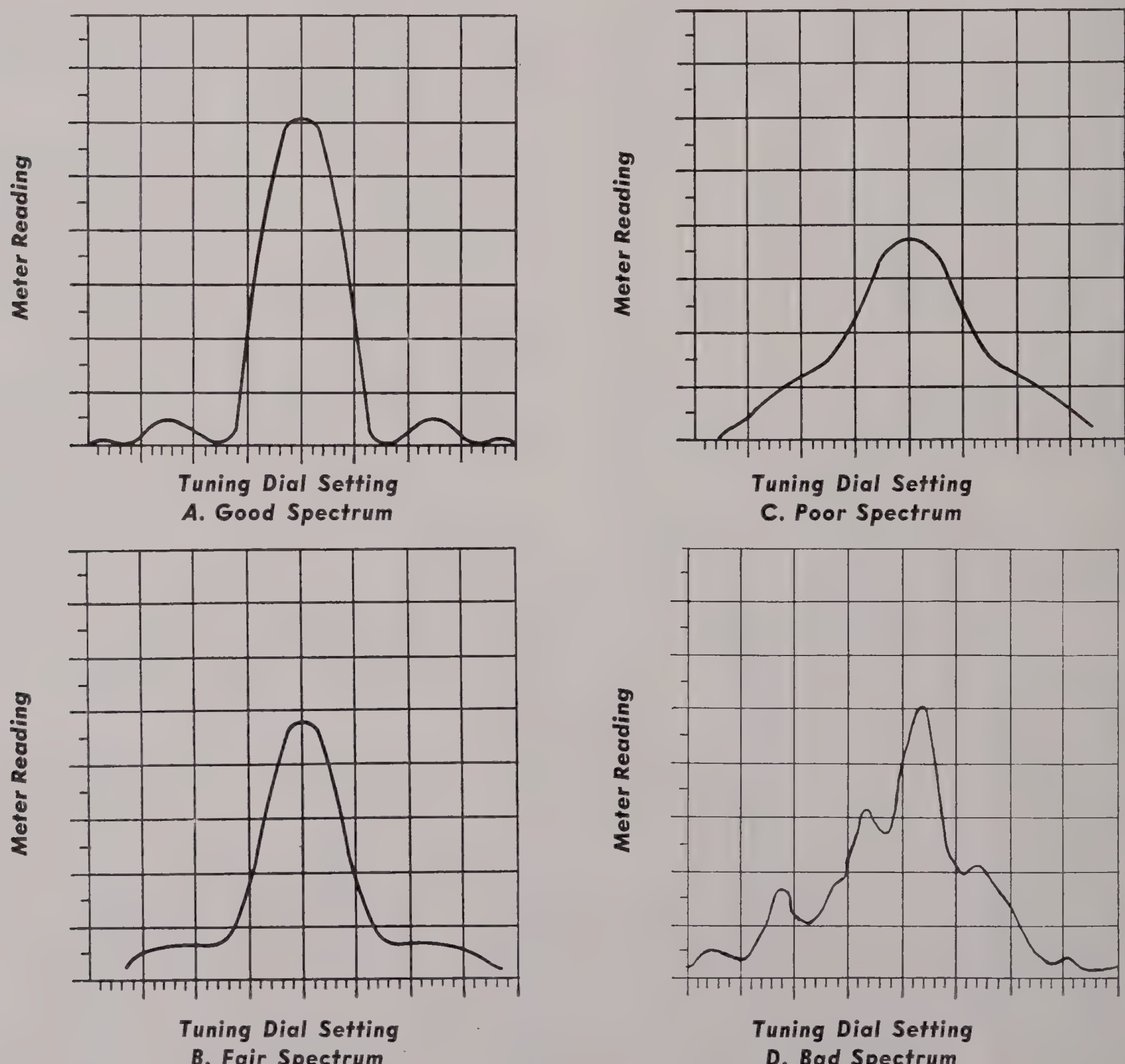


Figure 4-7. Spectrum Analysis Diagram

6. COMPARATIVE POWER CHECK

a. TEST PROCEDURE

(1) Set up the echo box and complete the ring-time measurement as described above.

(2) Rotate the METER SENSITIVITY control until the meter reads .5 MA.

(3) Record the dial setting of the METER SENSITIVITY control obtained above in the radar log book, or on other forms that may be supplied for this purpose.

b. ANALYSIS OF RESULTS

(1) In order to establish a standard for the power check, the above test should be first made on the radar set when it is known to be in excellent operating condition.

(2) Compare the meter sensitivity control setting with values obtained from previous tests, or the established standard. This test shows whether or not the radar transmitter is radiating its normal amount of power.

7. SPECTRUM ANALYSIS

In a short square pulse, such as the radar transmitter is designed to produce, the R-F energy is not all concentrated in a single frequency, but spreads out over a principal band about 2/L megacycles wide, and centers about the nominal frequency (L is the pulse width in microseconds). Beyond this band are weaker side bands. This distribution of energy by frequencies is known as the spectrum of the transmitter. Examination of the spectrum with a view to determining the condition of the transmitter is known as the spectrum analysis. When the test is properly performed and the results are correctly interpreted, incorrect radar operation is disclosed which might otherwise be difficult to locate.

a. TEST PROCEDURE.

(1) Set up the echo box as described above.

(2) Adjust the TUNING control for a maximum reading on the meter, re-adjusting the METER SENSITIVITY control as necessary to obtain a meter reading of approximately .8.

(3) Turn the TUNING control slowly in steps of one minor tuning control division, from a point well below the resonant frequency setting, to a point well above the resonant setting.

Call off the readings of the meter at regular intervals for another man to record.

Note

COVER THE FREQUENCY RANGE DESIRED BY TURNING THE TUNING CONTROL IN THE SAME DIRECTION, NOT BY TURNING IT BACK AND FORTH. IN THIS WAY, ERROR DUE TO ANY BACKLASH IN THE DIAL GEARING IS MINIMIZED.

(4) Construct a graph or chart (See figure 4-12) with the meter readings plotted against the position of the tuning control. The resulting graph should resemble one of those shown in figure 4-7, if plotted to the same scale. Blank sheets for such graphs are included in the back of this book.

b. ANALYSIS OF RESULTS.

(1) A radar transmitter in satisfactory condition should give a spectrum curve similar to figure 4-7A or 4-7B. Good curves are those in which the two halves are symmetrical, and there are deep, well-defined minimum points on both sides of the main peak.

(2) A curve without deep minima, (See figure 4-7C.) indicates that the transmitter output is frequency modulated during the pulse. This may be caused by a high voltage pulse (applied to the transmitter tube) whose sides are not steep enough, or by a pulse that does not have a flat top. It may also be due to an unstable transmitting tube, or to a tube that is operated with improper voltage, current or magnetic field.

(3) When the spectrum is extremely irregular, figure 4-7D, it is an indication of severe frequency modulation. This will probably cause trouble in the receiver automatic control, as well as some general loss of signal strength. When the spectrum has two large peaks quite far apart, this indicates that the transmitter is double moding, perhaps because of bad standing waves in the transmission line or a bad transmitter tube.

(4) In the case of a good or fair spectrum curve with sharply defined minima on both sides of the main peak, the distance between these two minima indicates the duration of the transmitter pulse.

(5) Since the duration of the pulse determines the distribution of power in the sideband frequencies, the pulse length may be found from the spectrum graph. The procedure is to determine the distance in megacycles between the minima on either side of the main peak, (See figure 4-7A.) and then apply the following equation:

$$L = \text{Pulse length in microseconds} = \frac{2}{\text{distance in megacycles between minima.}}$$

(6) Any great change in the spacing in megacycles of the minima of the spectrum from that obtained with a radar set of the same type, indicates an improper pulse duration.

(7) The shorter the pulse the wider the frequency band which the signals occupy. This shows on the graph as a wide span between the minima of the curve.

8. TEST FOR UNSTABLE RADAR OPERATION.

Unstable operation of a radar may be caused by misfiring or multiple moding. It may also be caused by im-

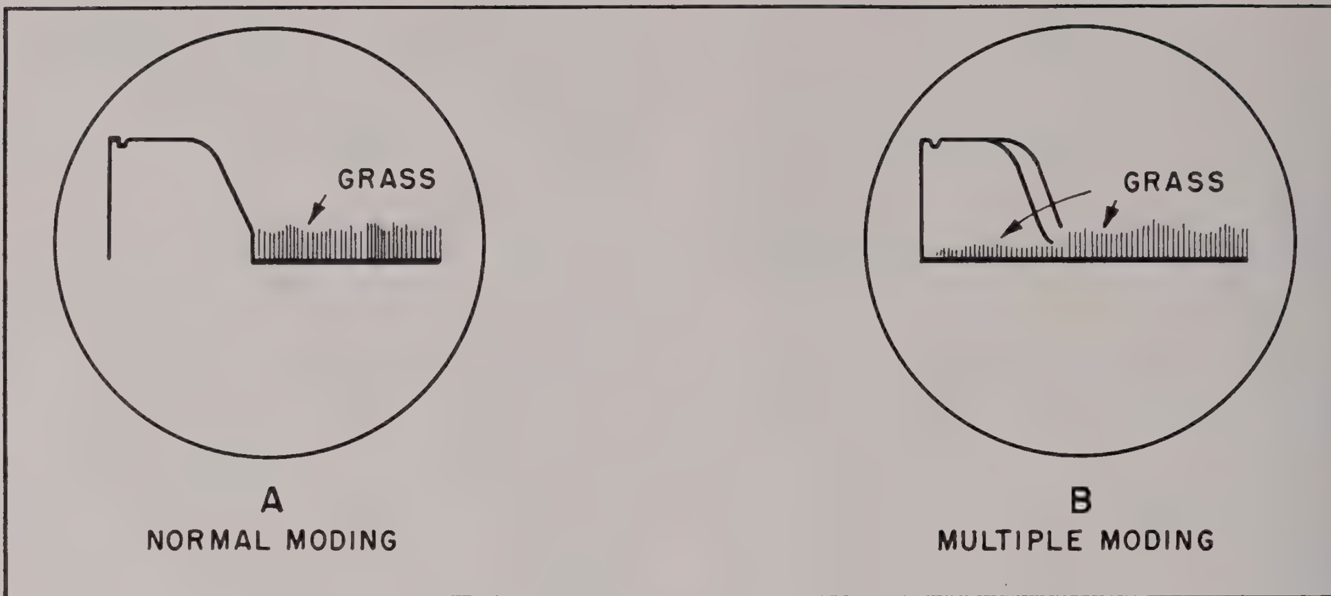


Figure 4-8—Ringtime Moding Patterns

proper filtering of the local oscillator voltages, or by automatic frequency control jitter. The test requires the use of an A-scope and is applicable to radar sets that have PPI only if a syncroscope such as Oscilloscope TS-34/AP is available.

a. TEST PROCEDURE.

(1) Set up the echo box and complete the operation described in paragraph 5 of this section.

(2) Turn the METER SENSITIVITY control to a point giving a usable indication on the meter (.6 MA or less).

(3) Carefully peak the TUNING control to the radar frequency.

(4) Observe the ringtime pattern on the A-scope or syncroscope.

b. ANALYSIS OF TEST.

(1) If the radar transmitter is operating normally, a ringtime pattern similar to that shown in figure 4-8A, should be obtained.

(2) If grass is showing at part or all of the bottom of the ringtime trace as shown in figure 4-8B, it is an indication that the transmitter is mis-firing or possibly multiple moding.

(3) If a decay line is present which has a tendency to appear double, look for improper heater connection or ripple on the local oscillator supply.

(4) If a jittery multiple decay trace is present having one or two alternate positions, listen for arcing in the R-F line.

(5) If a fuzzy multiple decay trace is present, check to see that the echo box is properly tuned.

(6) If a jittery multiple decay trace is present having many positions all close together, suspect AFC jitter.

9. TRANSMITTER FREQUENCY PULLING

a. TEST PROCEDURE.

(1) If a directional coupler is included in the radar set, connect the echo box by this method.

(2) If no directional coupler is provided, attach both the echo box and the pick-up antenna to the radar antenna, if possible, in such a fashion that the echo box moves with the radar antenna. The directional coupler should always be used when possible. Attachment of the echo box and its antenna to the radar antenna may be difficult or impossible.

(3) With the antenna stopped in a direction in which there are no close obstructions, tune the echo box as directed in paragraph 5 of this section.

(4) Allow the antenna to rotate while observing the pattern on the PPI. If nearby echoes are troublesome, reduce the gain of the radar set with the receiver gain control.

b. ANALYSIS OF TEST.—If the transmitter is operating normally, good ringtime pattern will be seen as shown in figure 4-4. If there are blank spaces on the PPI, or if the ringtime is reduced on certain azimuths, then the transmitter frequency is being pulled. (See figure 4-9A.) In such a case the meter reading will also fluctuate as the radar antenna is rotated slowly. Transmitter frequency measurements at several azimuths may also be used to confirm these difficulties. The pulling may be caused by a bad rotating joint, or by a reflecting surface near the antenna.

Figure 4-9. Transmitter Pulling on PPI Screen

10. AUTOMATIC FREQUENCY CONTROL CHECK

When the transmitter is pulled as in figure 4-9A, it is important to know whether the local oscillator is following in frequency, thus keeping the receiver in tune.

a. TEST PROCEDURE.

(1) With the echo box set up as in paragraph 9 of this section, stop the antenna on an azimuth on which the ringtime pattern is broken and retune.

(2) Rotate the antenna and again examine the PPI pattern.

b. ANALYSIS OF TEST.—If the ringtime is now good on the azimuth on which the echo box was retuned, the AFC is in operation on that azimuth, and the local oscillator is following the pulling of the transmitter. As shown in figure 4-9B, the ringtime may now be decreased on those azimuths where it was originally good. If the AFC does not follow, the pulling may be excessive, or the AFC may be at fault.

c. CHECKING FOR AFC LOCKING.—This check will show whether the AFC is locked on the proper frequency.

(1) TEST PROCEDURE.

(a) Stop the radar antenna and tune the echo box for maximum meter reading.

(b) Turn off the AFC switch and tune the local oscillator for maximum ringtime.

(c) Throw the AFC on.

(2) ANALYSIS OF TEST.—If the ringtime decreases even slightly, the AFC is locking on the wrong frequency or is failing to lock. The probable cause of AFC failure is a bad spectrum, the fact that the local oscillator is tuned to a frequency on the wrong side of the transmitter frequency, or incorrect adjustment of the local oscillator cavity. It is not advisable to realign the AFC circuit until it has been determined by the elimination of other possibilities that this is necessary. For further information see the radar instruction book.

11. RECEIVER AND T-R BOX RECOVERY TIME CHECK.

a. This test requires the use of an A-scope and is applicable to radar sets which have a PPI scope, only if a synchroscope such as oscilloscope TS-34/AP or equivalent is available.

(1) Set up the echo box as described in paragraph 5 of this section.

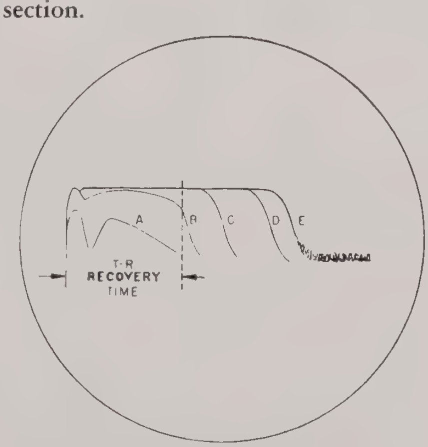


Figure 4-10. T-R Recovery Time On A-Scope

(2) Peak the TUNING control and adjust the METER SENSITIVITY control to a point giving a usable indication.

(3) After a good ringtime pattern has been obtained similar to curve E of figure 4-10, slowly start to reduce the receiver gain setting, or better, to de-tune the receiver local oscillator. A pattern will result such as curve D, having the same relative shape as curve E. Further slight reduction in gain setting will produce another pattern such as curve C, again similar in shape to curve E. Continue until a change occurs in the slope of the curve as in curve B. This point of change marks the T-R box recovery time of the radar set. For a good radar set, the T-R recovery should be one mile or less. If the gain control is reduced still further, a greatly distorted pattern will appear as in curve A of figure 4-10. If the above procedure does not produce a series of curves as indicated, giving a T-R recovery point, and if the ringtime is short, it is possible that the T-R recovery time is much too high, (greater than ringtime) and a new T-R tube is needed. Check the keep-alive current and the polarity of the voltage applied to the keep-alive electrode. The keep-alive current should be between 0.1 and 0.2 ma., and the polarity of the voltage should be negative. Greater current or a positive voltage will shorten T-R tube life.

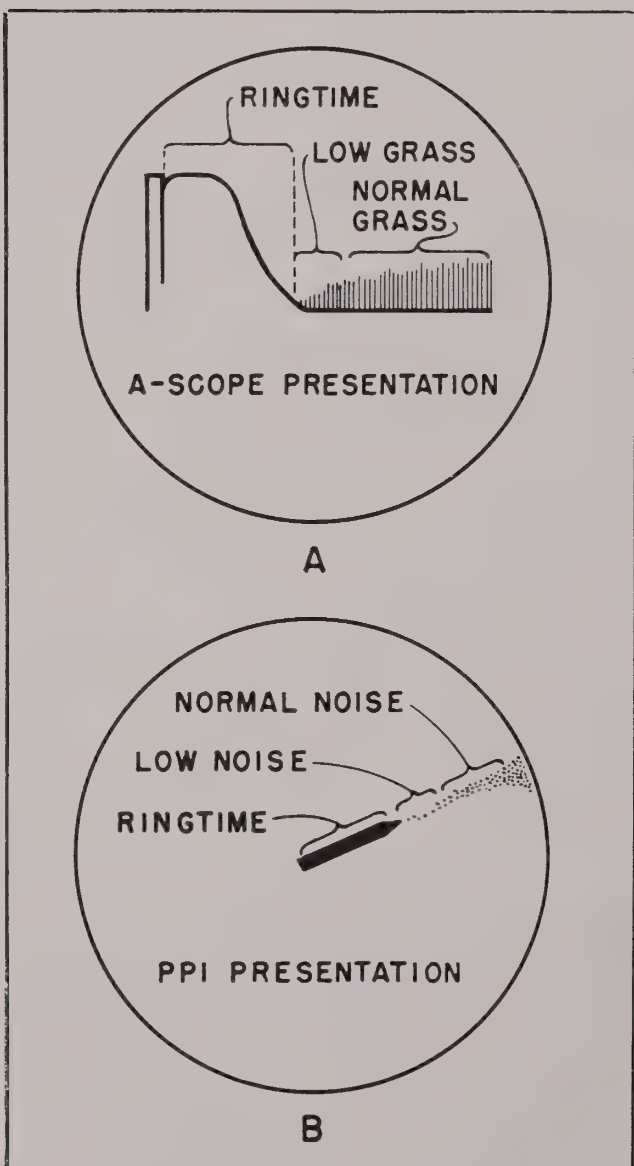


Figure 4-11. Patterns Showing Slow Receiver Recovery

b. PROCEDURE FOR RECEIVER RECOVERY TIME CHECK.

(1) After having determined that the T-R box is operating properly as described, detune the echo box.

(2) Adjust the radar receiver again so that approximately one-quarter inch of grass is showing on the A-scope. For PPI presentation, the receiver gain control should be adjusted so that the noise trace is low.

(3) Retune the echo box to resonance and observe the indicator pattern. If the receiver recovery time is normal, the noise or grass will re-appear immediately after the end of the ringtime trace, also the noise will be as strong as that observed when the echo box was detuned. If recovery is slow, the noise will be weak and will not reach normal amplitude for some time after the end of the ringtime trace, as shown in figure 4-11. In severe cases, normal noise may not re-appear at all. Receiver non-recovery is usually an I-F tube or video defect; one which will make a radar set susceptible to jamming.

12. CAUSE AND EFFECT CHART

When the user has become familiar with the test procedures and measurements, the echo box may be used for rapid trouble shooting. Radar troubles may be checked with the information contained in figure 4-13.

13. USING THE CRYSTAL CHECKER

a. Before inserting a crystal in the holder, hold the crystal by its body and touch a finger to the grounding spring to discharge any electrostatic charges that may be present. Then put the crystal in the holder.

b. TESTING.—The following step-by-step procedure should be done by turning the Rotary Selector Switch in a clockwise direction in the order outlined, and using the "PUSH" Crystal Checker Switch for each reading.

(1) MOUNTING ADJUSTMENT.—Put the Rotary Selector Switch on "MTG. ADJ. 1" and turn the METER ADJ. knob until the meter reads full scale.

(2) FORWARD RESISTANCE.—Put the rotary Selector Switch on "FWD, 2" and read the forward resistance directly from the scale on the meter. Discard the crystal if the forward resistance is greater than .5 kilohms (500 ohms).

(3) BACK RESISTANCE.—Put the Rotary Selector Switch on "BACK 3" and read the back resistance directly from the meter as in (2) above. Discard the crystal if the ratio of backward resistance to forward resistance is less than 10 to one.

(4) METER ADJUSTMENT.—Turn the Rotary Selector Switch to "MTR. ADJ. 4" and turn the METER ADJ. knob until the meter reads full scale.

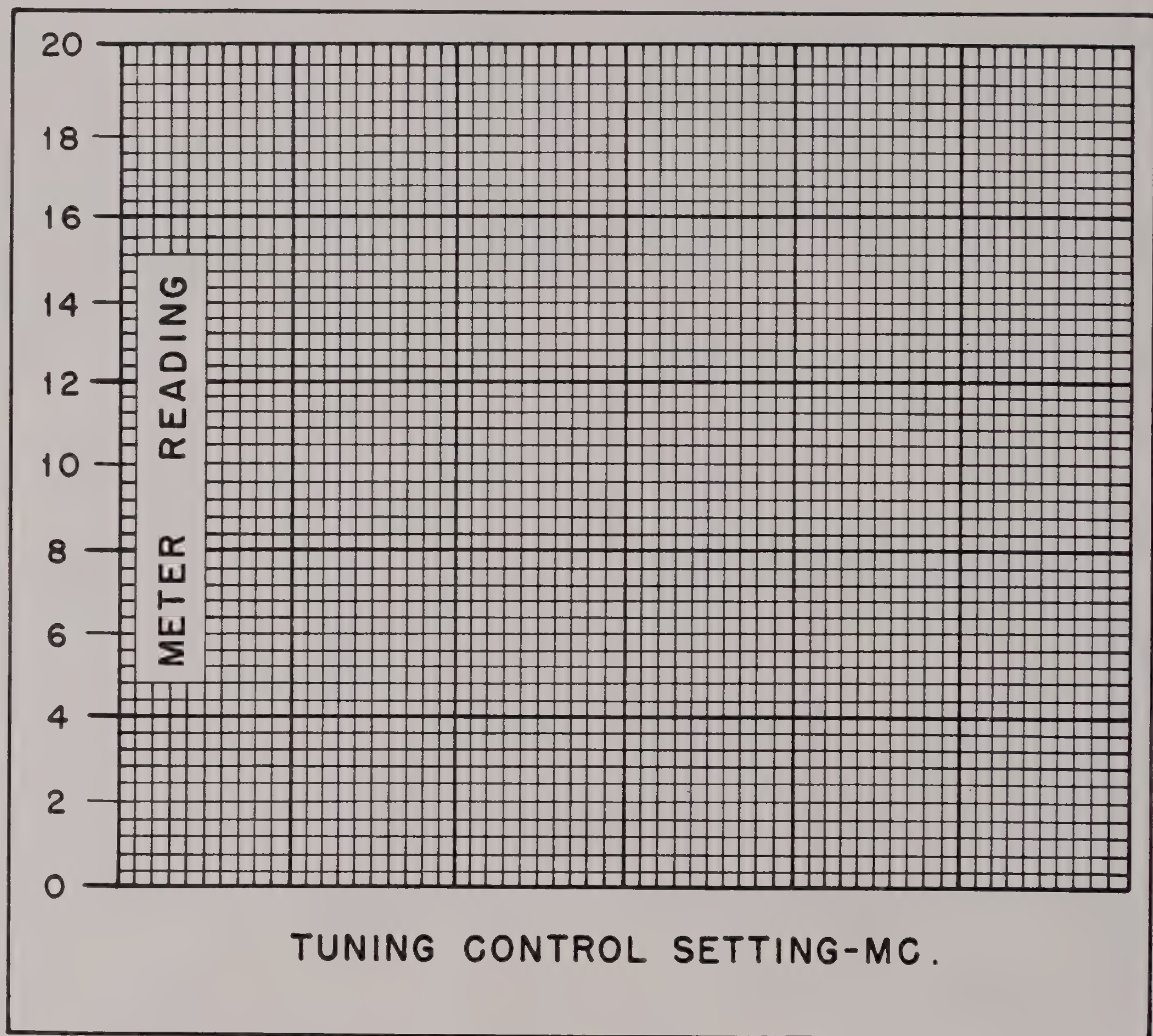
(5) MEASURE.—Put the Rotary Selector Switch on "MEAS. 5" and read the magnitude of the back current on the lower scale of the meter. Discard the crystal if the value of back current thus obtained is in excess of the value shown in the following table for that type of crystal.

Crystal Rectifier	Maximum Back Current in Milliamperes
1N21	.40
1N21A	.175
1N21B	.125
1N23	.40
1N23A	.30
1N23B	.175

The above values for back current were determined at an ambient temperature of 22°C (70°F). Since the DC characteristics of the crystal rectifier vary somewhat with temperature, the following table is to be used as a modification of the above values for maximum allowable back current if tests are conducted at ambient temperatures differing appreciably from 21°C (70°F).

Crystal Rectifier	Back Current at 1 Volt −15°C (5°F)	0°C (32°F)	21°C (70°F)	50°C (122°F)
1N21	.32	.35	.40	.50
1N21A	.144	.152	.175	.22
1N23	.32	.35	.40	.50
1N23A	.24	.26	.30	.375
1N23B	.144	.152	.175	.22

SPECTRUM ANALYSIS CHART



RADAR MODEL ____________________

RADAR SERIAL ____________________

ECHO BOX TS-311B/UP SERIAL ____________________

SHIP OR STATION ____________________

TESTED BY ____________________

DATE ____________________

RADAR CONDITIONS ____________________

____

Figure 4-12. Spectrum Analysis Chart

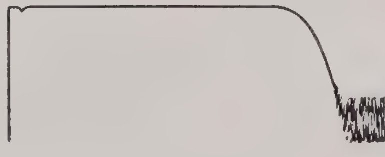
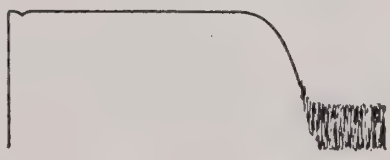
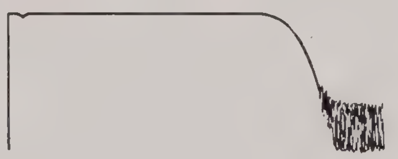
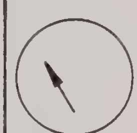
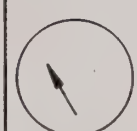
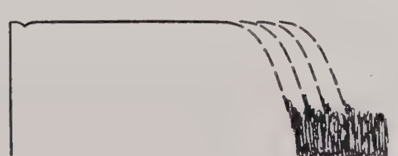
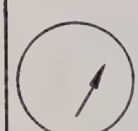
EFFECT	APPEARANCE ON		PROBABLE CAUSE
	RADAR INDICATOR	TEST SET METER	
Ringtime satisfactory, test set output reading satisfactory.			Radar performance satisfactory.
Ringtime low, test set output reading satisfactory.			Receiver trouble: detuned mixer or local oscillator, bad crystal, excessive i-f noise from first pre-amp stage, adjustment of coupling loops or probes in mixer cavity. Detuned T-R box.
Ringtime low, test set output reading very low.			Low power output. Check spectrum.
Ringtime low, test set output reading low.			Trouble probably in transmitter and receiver and/or trouble in transmission line, if dipole is being used.
Ringtime erratic, test set output reading steady.			Test set slightly detuned. Faulty pulsing, double moding transmitter, or local oscillator power supply trouble. Check spectrum.

Figure 4-13. Cause and Effect Chart (Page 1 of 2 Pages)

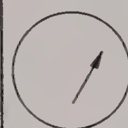
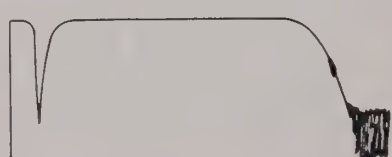
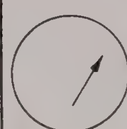
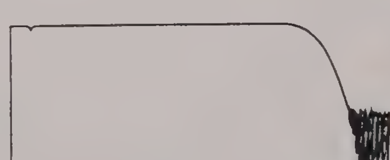
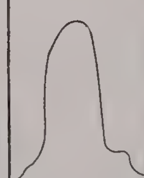
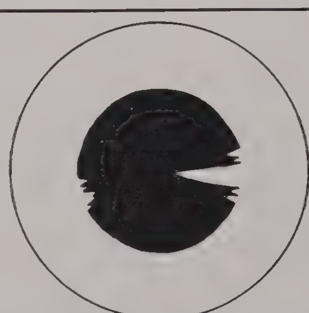
EFFECT	APPEARANCE ON RADAR INDICATOR	APPEARANCE ON TEST SET METER	PROBABLE CAUSE
Ringtime erratic, test set output reading erratic.			Faulty transmission line or poor connections — condition worse when line is rapped.
End of ringtime not steep but slopes gradually; perhaps even excessive ringing. Grass appears coarse. Test set output reading steady and satisfactory.			Oscillating i-f and or narrow band receiver.
Pronounced dip in ringtime at end of pulse.			Bad T-R tube.
Ringtime very slightly low, poor or bad spectrum.			Transmitter trouble.
Blank spaces or rough pattern on PPI ringtime indicator, test set output reading varies as radar antenna is rotated.			Frequency pulling of transmitter due to bad rotating joint or to reflecting object near radar antenna.

Figure 4-13. Cause and Effect Chart (Page 2 of 2 Pages)

SECTION 5
OPERATOR'S MAINTENANCE

1. REPLACEMENTS

a. The only maintenance that it is advisable for the operator to attempt on the Echo Box TS-311B/UP consists of the following two replacements.

b. Replacement of Crystal CR-101 may be performed according to instructions contained in Section 7, paragraph 3-b.

c. Replacement of the battery in BT-101 requires lifting the unit out of its case (See figure 7-3), removing the cover of the battery holder (BT-101) and replacing the battery with another JAN-BA2030/U 1½ volt cell. The battery should be replaced when it is no longer possible to adjust the meter to full scale as described in Section 4, paragraphs 13 b (1) to (4).

SECTION 6
PREVENTIVE MAINTENANCE

The construction of the ECHO BOX TS-311B/UP is such that preventive maintenance is unnecessary. Any difficulty that may arise should be treated as corrective maintenance which is covered in Section 7 of this instruction book. Treat the equipment carefully and keep it as free from dust and moisture as possible.

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NBS-383, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS in the franked envelope which is provided. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest District Printing and Publication Office.

U. S. NAVY
ELECTRONIC
FAILURE REPORT
NAVSHIPS 383 (REV. 4-49)

REPORT—SHIPS-34

NOTICE: 1. Read instructions interleaved in this pad prior to preparing report.
2. Report all failures (Electronic, electrical, and mechanical).
3. Use separate sheet to report each part failure.

REPORT NO. ______________

DATE OF FAILURE ______________

EQUIPMENT INSTALLED IN (*Number and name of ship or station*)	REPAIRS MADE BY (*Number and name of ship, yard, tender, etc.*)	LEAVE BLANK	REPAIRED BY (*Name and rate of person*)

SERVICE USING EQUIPMENT (*Check one*): 1 ☐ NAVY 2 ☐ USCG 3 ☐ USMC 4 ☐ ARMY 5 ☐ AIR FORCE

TYPE ACTIVITY USING EQUIPMENT (*Check one*): 1 ☐ SHIP 2 ☐ SHORE 3 ☐ AMPHIBIOUS 4 ☐ AIR-BORNE 5 ☐ OTHER ______ (*Specify*)

EQUIPMENT CATEGORY (*Check one*): 1 ☐ RADIO 2 ☐ RADAR 3 ☐ SONAR 4 ☐ TEST 5 ☐ ORDNANCE 6 ☐ NANCY AND RADIAC 8 ☐ POWER 9 ______ OTHER (*Specify*)

NAME PLATE DATA — EQUIPMENT

MODEL DESIGNATION	SERIAL NO.	NAME OF CONTRACTOR
LEAVE BLANK	CONTRACT NO.	DATE INSTALLED

MAJOR UNIT INVOLVED

TYPE NO. AND NAME
SERIAL NO.

PART FAILURE DATA (*Check one*): ☐ TUBE ☐ OTHER

COMPLETE TUBE TYPE, OR NAME AND NAVY TYPE NO. OF PART		STANDARD NAVY STOCK NO. (*See note 10*)	SYMBOL DESIGNATION (*V-101, R-201, etc.*)	FAILED IN (*Check one*) 1 ☐ OPERATION 2 ☐ FAULTY PACKAGING 3 ☐ HANDLING 4 ______ OTHER (*Specify*)
APPROXIMATE LIFE (*Hours*)	LEAVE BLANK	MANUFACTURER'S NAME	SERIAL NO. OF TUBE OR PART	ARMY STOCK NO. (*USMC only*) / MFRS' DATA (*See note 13*)

CHECK TYPE OF FAILURE

002 ☐ AIRLEAK	130 ☐ CHANGE OF VALUE	300 ☐ GROUNDED	360 ☐ INTERMITTENT OPERATION	225 ☐ MFR'S DEFECT	003 ☐ OPEN FILAMENT	540 ☐ PUNCTURED	620 ☐ SHORTED TO PRIMARY
007 ☐ ARCING	170 ☐ CORRODED	310 ☐ HANDLING IMPROPER	380 ☐ LEAKAGE	009 ☐ MICROPHONIC	460 ☐ OPEN PRIMARY	011 ☐ SCREEN DEFECTS	630 ☐ SHORTED TO SECONDARY
070 ☐ BROKEN	190 ☐ CRACKED	320 ☐ HIGH VOLTAGE BREAK-DOWN	013 ☐ LOOSE BASE	008 ☐ NOISY	470 ☐ OPEN SECONDARY	005 ☐ SHORTED INTERMITTENT	020 ☐ UNSTABLE OPERATION
014 ☐ BROKEN BASE	330 ☐ EXCESSIVE HUM	340 ☐ INSTALLED IMPROPERLY	012 ☐ LOOSE ELEMENTS	022 ☐ NO OSCIL-LATION	480 ☐ OVERHEATED	006 ☐ SHORTED PERMANENT	☐ OTHER (*Specify in remarks*)
015 ☐ BROKEN GLASS	001 ☐ GASSY	350 ☐ INSULATION BREAK-DOWN	004 ☐ LOW EMISSION	440 ☐ OLD AGE (*Specify in remarks*)	021 ☐ OVERLOADED	600 ☐ SHORTED TO CASE	
080 ☐ BURNED OUT	016 ☐ GLASS STRAIN		040 ☐ MECHANICAL BINDING	450 ☐ OPEN	010 ☐ POOR FOCUS	610 ☐ SHORTED TO FRAME	GPO 16—58703-1

REMARKS: INCLUDE CAUSE OF FAILURE AND SUGGESTED CHANGES (*Continue remarks on reverse side*)

LEAVE BLANK

SECTION 7
CORRECTIVE MAINTENANCE

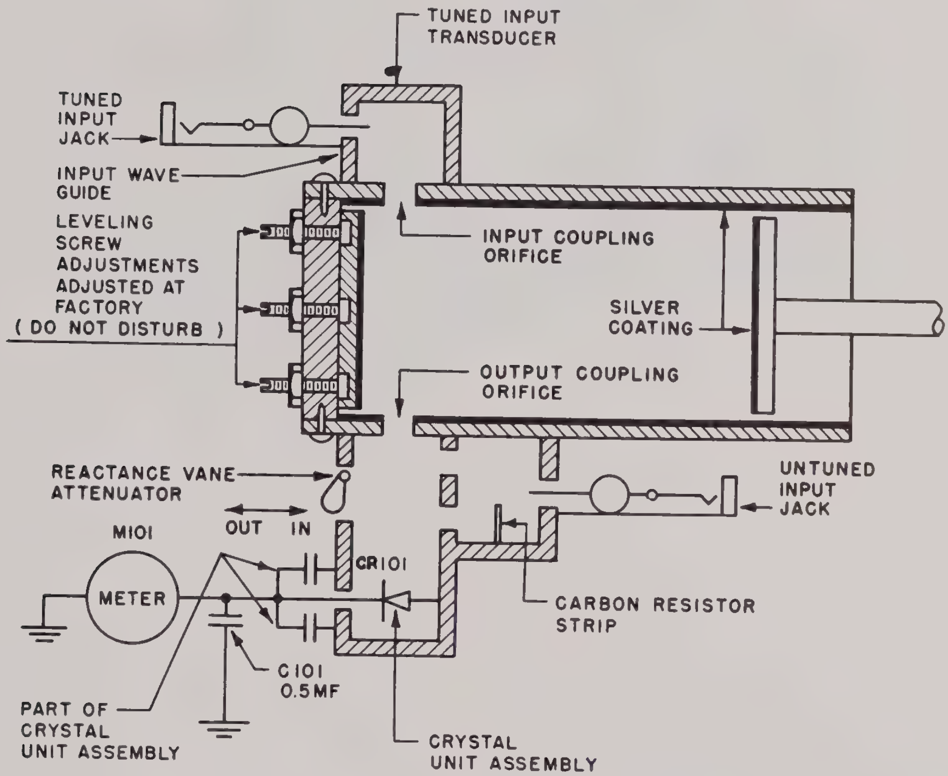


Figure 7-1. Functional Schematic Diagram

1. GENERAL.

Maintaining and servicing this equipment should be performed with extreme care. Repairs, other than the replacement of crystals, should be performed only by competent personnel supplied with adequate tools and instruments. An inexperienced operator attempting to locate and repair trouble within the echo box, may damage the equipment to such an extent that shipment to a repair base or the factory will be necessary. Attempting to adjust the cavity or tuning control gearing is particularly dangerous and should be avoided at all times.

2. TROUBLE SHOOTING.

a. LOW RESONANCE INDICATOR READING.

The meter will read low when the radar power is low, the spectrum of the transmitter is bad or the pulse is too short. These are among the radar faults which it is the purpose of the echo box to indicate. When these conditions do not prevail, the echo box meter may read low due to the following causes:

(1) The echo box is tuned to a side lobe of the transmitter spectrum. If the transmitter spectrum has large side lobes it is possible, unknowingly, to peak the meter on one of these lobes. This arises only by careless tuning, and is readily avoided by first tuning completely through the spectrum, and then peaking the meter by careful adjustment.

(2) METER SENSITIVITY control set too low.

(3) Burned out or damaged echo box crystal.

(4) Damaged coaxial connectors or faults in the coaxial cable.

(5) Directional coupler installed backwards or pick-up antenna in the wrong position.

(6) Faulty capacitor, C-101 opened or shorted. (See figure 7-1).

(7) Resonance indicator damaged, shorted or dis-

connected. If there is reason to suspect that the meter has been damaged, it may be tested by connecting it to a single 1.5 volt dry cell through a 100,000 ohm resistor. Under these conditions the meter should read one-half scale.

CAUTION

Never test the RESONANCE INDICATOR with an ohmmeter. The movement is sensitive enough to be damaged by the current from the battery in the ohmmeter. The case of this meter should never be opened except under absolutely dust free conditions, nor should steel tools be used on the internal screws of the meter. It contains a very strong magnet which will attract any iron filings, etc., that happen to be in the vicinity. There is danger that these filings may get into the movement and cause the needle to stick.

b. LOW RINGTIME WITH NORMAL METER READINGS.

Presuming that the radar receiver sensitivity, the T-R box recovery, and the echo box meter readings are normal, a reduction in ringtime can be caused by the following faults in the echo box:

(1) Meter reading control readjusted when low meter readings, as in paragraph two, existed. If the control has been readjusted, using a radar system with reduced transmitter power, the crystal may be coupled too closely to the echo box cavity. This closer coupling to the cavity may increase the meter reading to a normal value, but the ringtime will still remain low. In this case the true difficulty is low meter reading and the causes are indicated above.

(2) Damage such as corrosion of the silver plating on the inner cavity walls over a considerable area, or bending of the cavity wall, or change in the end plate leveling screws, which will impair the ringing ability of the echo box.

3. GENERAL REPAIRS.

a. When replacing mechanical parts in the equipment, use extreme care in dis-assembling and re-assembling any part of the unit. Use caution when working inside of the cavity so as not to scratch the silver surface. Secure screws snugly, but do not over tighten.

b. The crystal holder in the CRYSTAL CHECKING unit should be replaced as a complete assembly if the contact springs can no longer make a satisfactory contact when the crystal is inserted. The crystal holder is easily removed from the panel by first removing the wires from the terminals and then the flat head screw, nut and lockwasher by which the holder assembly is mounted on the panel.

CAUTION

Do not tighten, or attempt to adjust the three screws marked A indicated in Figure 7-2, Top View of Panel Assembly Echo Box TS-311B/UP, and the one screw marked A indicated in Figure 7-3, Bottom View of Panel Assembly Echo Box TS-311B/UP. If these screws are disturbed, serious damage will be done to the echo box. These screws are a factory adjustment and must not be altered. Under no circumstances should the cavity be opened unless it is absolutely necessary, as in so doing the ringing ability of the echo box may be seriously disturbed.

4. REPLACEMENT OF CRYSTAL RECTIFIER.

a. Refer to Figure 7-2. To remove the crystal, loosen the knurled portion of the crystal holder indicated by the letter B. Carefully pull the crystal holder out of its socket. Next unscrew the knurled portion marked C. The new crystal should be replaced in the reverse order.

b. In many cases the body of the person handling the crystal is not at ground potential due to his movement across an insulated floor or deck. This is particularly likely to be the case when the humidity is low, as on a dry, cold day or in heated quarters. The static charge carried by the body may be accidently discharged through the crystal unit if it is held by the base, and the tip is brought into contact with grounded equipment. The same might occur if the tip of the unit is at ground potential, and its base is touched by a person or object carrying a static charge. Similarly, a static discharge might take place if the crystal is handled from one person to another. In order to avoid damage, certain precautions should always be taken.

(2) Touch the equipment with your bare hands before attempting to insert the crystal.

(3) If you want to hand the unit to another person, touch his bare hand first, in order to equalize any static charge.

(4) Crystals are also apt to be damaged by voltages in connecting wires, induced by neighboring electrical equipment. Thus, voltage shocks may be delivered to the crystal by the opening and closing of near-by electrical circuits. Such damage should be avoided by careful shielding of the connecting wire, and by keeping the crystal always wrapped in metal foil or in a metal box when not in use.

(5) If a crystal is exposed to a strong radio frequency field, it may easily absorb enough energy to damage or destroy it. Since it often may be necessary to remove a crystal from its holder or from a spare crystal compartment when in the vicinity of a radar transmitter, the transmitter or other source of strong frequency field must be shut down first.

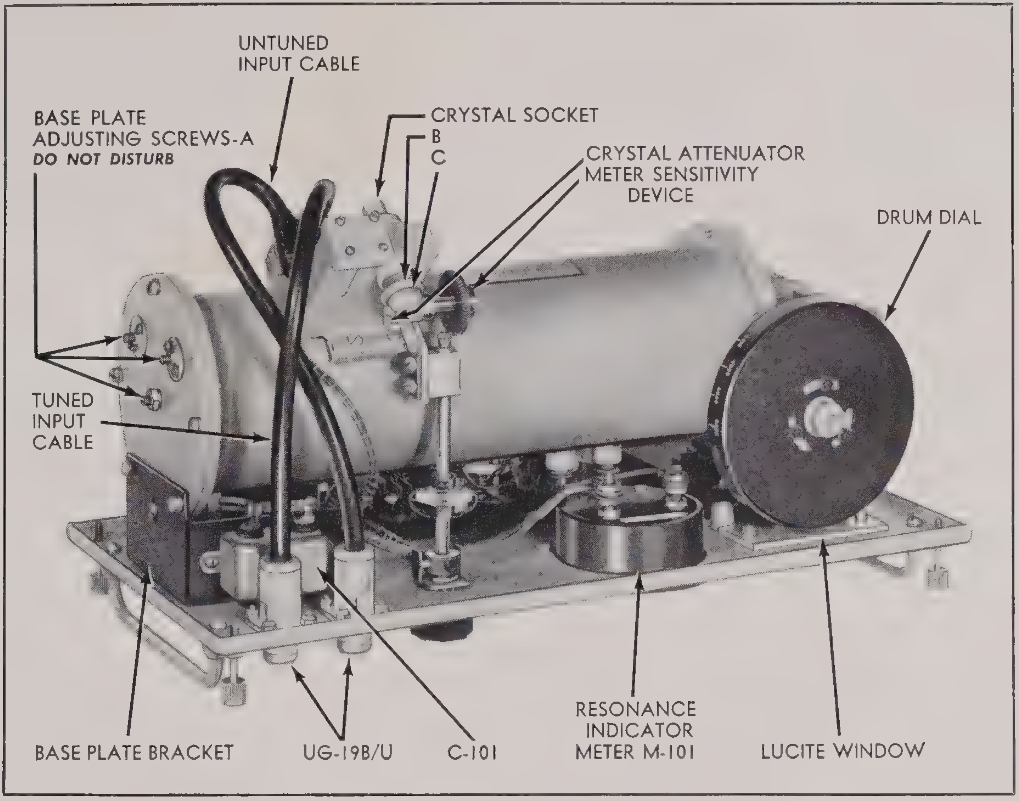


Figure 7-2. Top View of Panel Assembly Echo Box TS-311B/UP

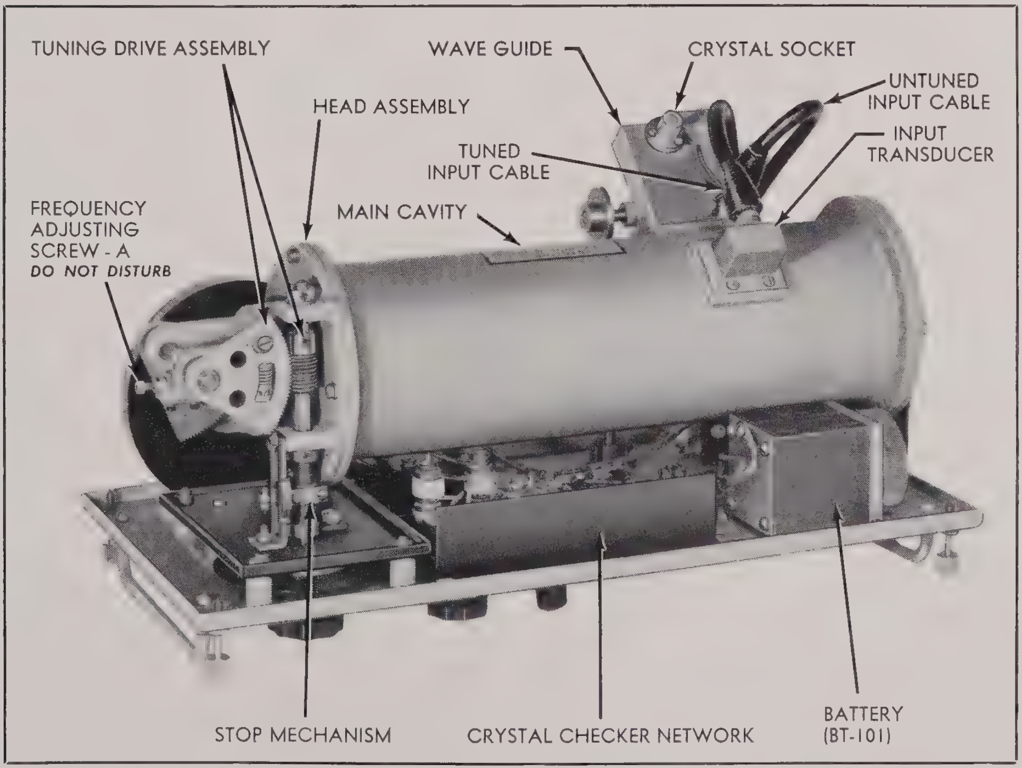


Figure 7-3. Bottom View of Panel Assembly Echo Box TS-311B/UP

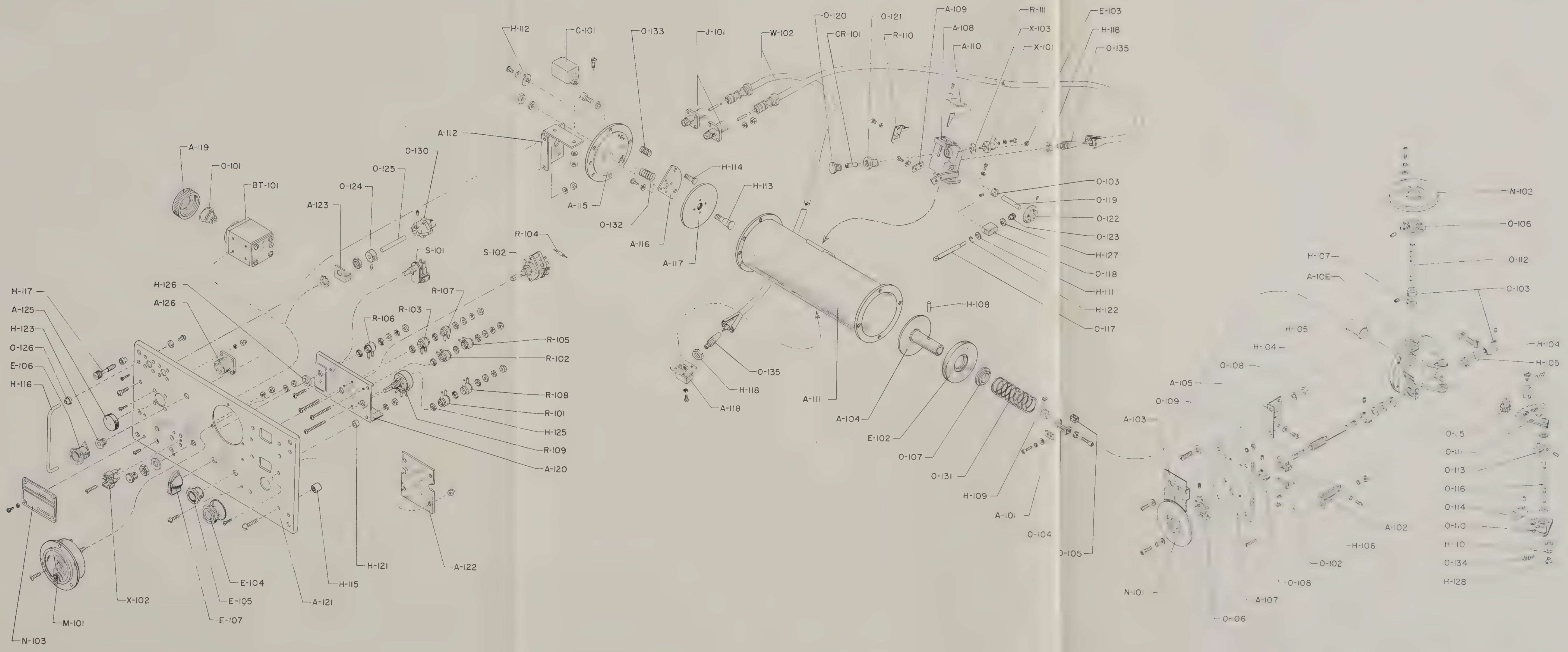


Figure 7-4. Exploded Drawing of Echo Box TS-311B/UP

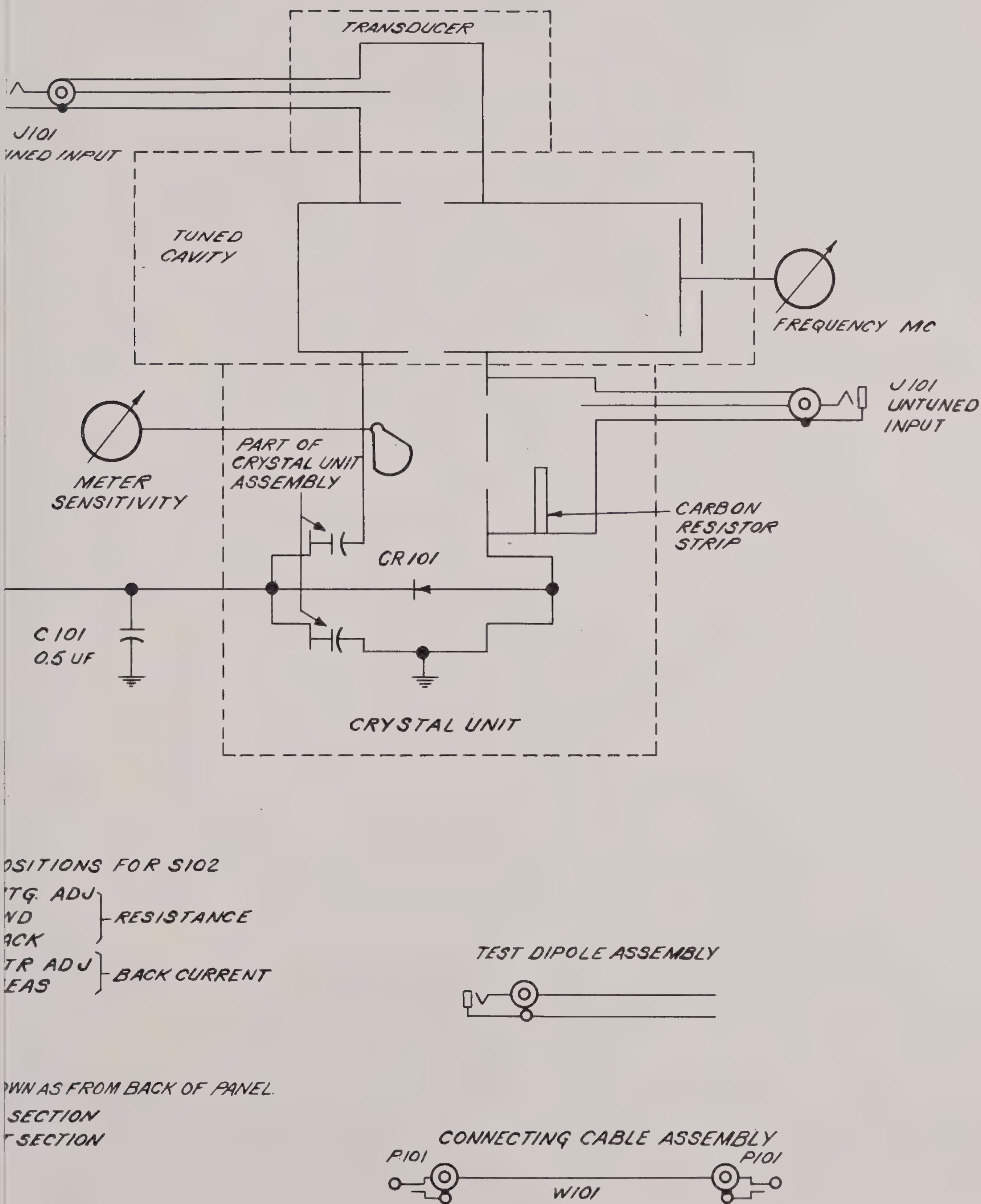


Figure 7-5. Schematic Diagram Echo Box TS-311B/UP

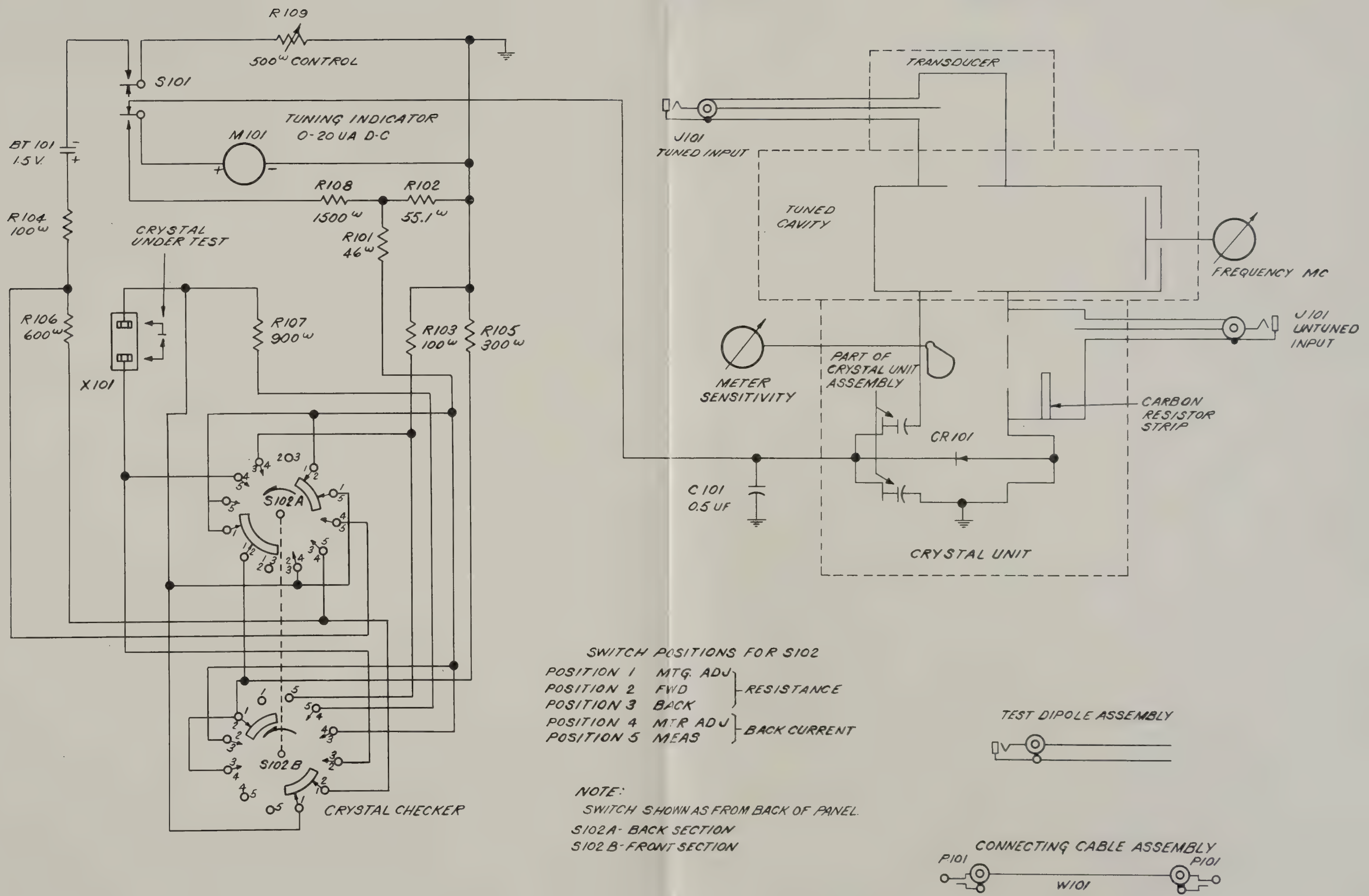


Figure 7-5. Schematic Diagram Echo Box TS-311B/UP

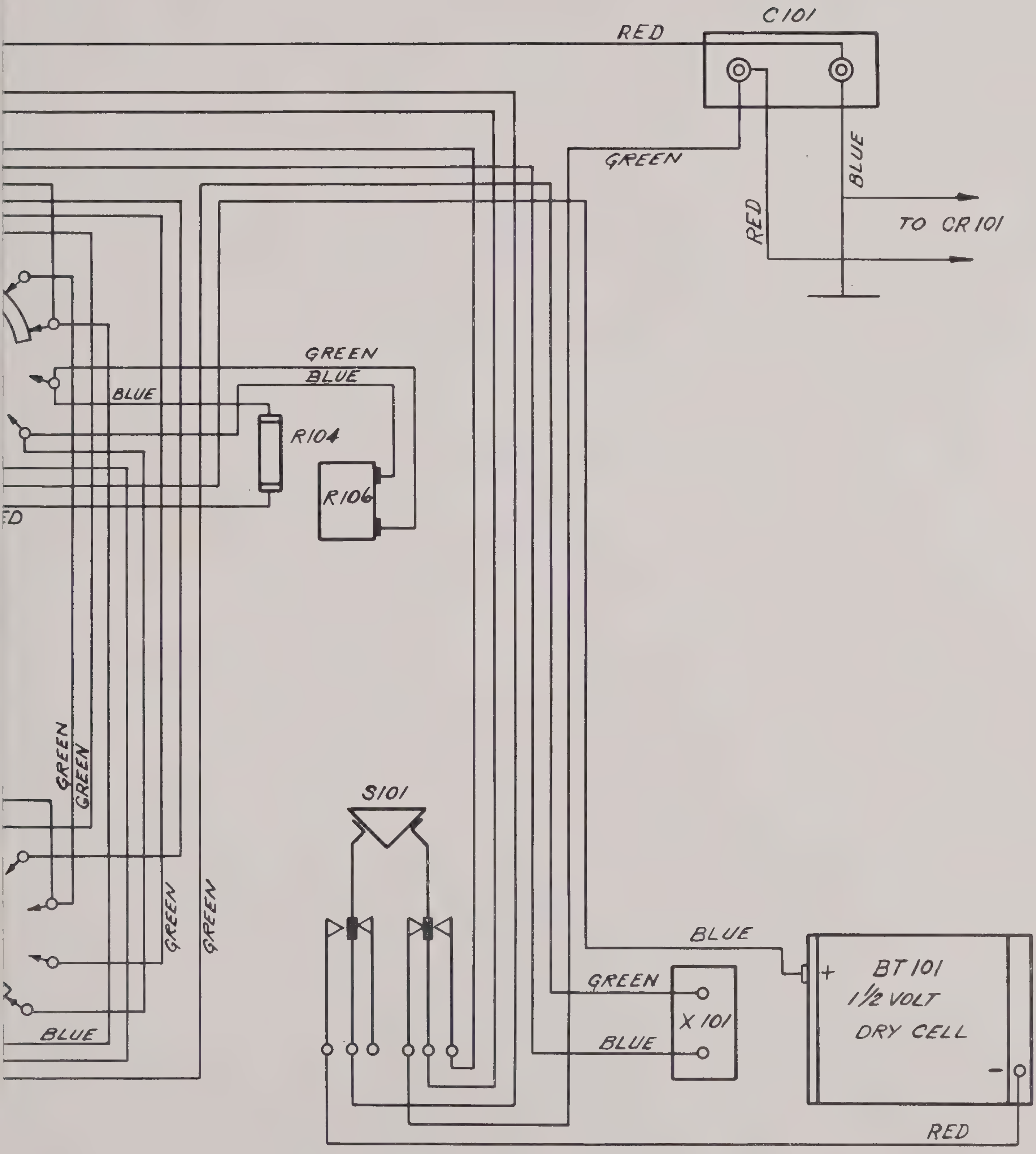


Figure 7-6. Wiring Diagram Echo Box TS-311B/UP

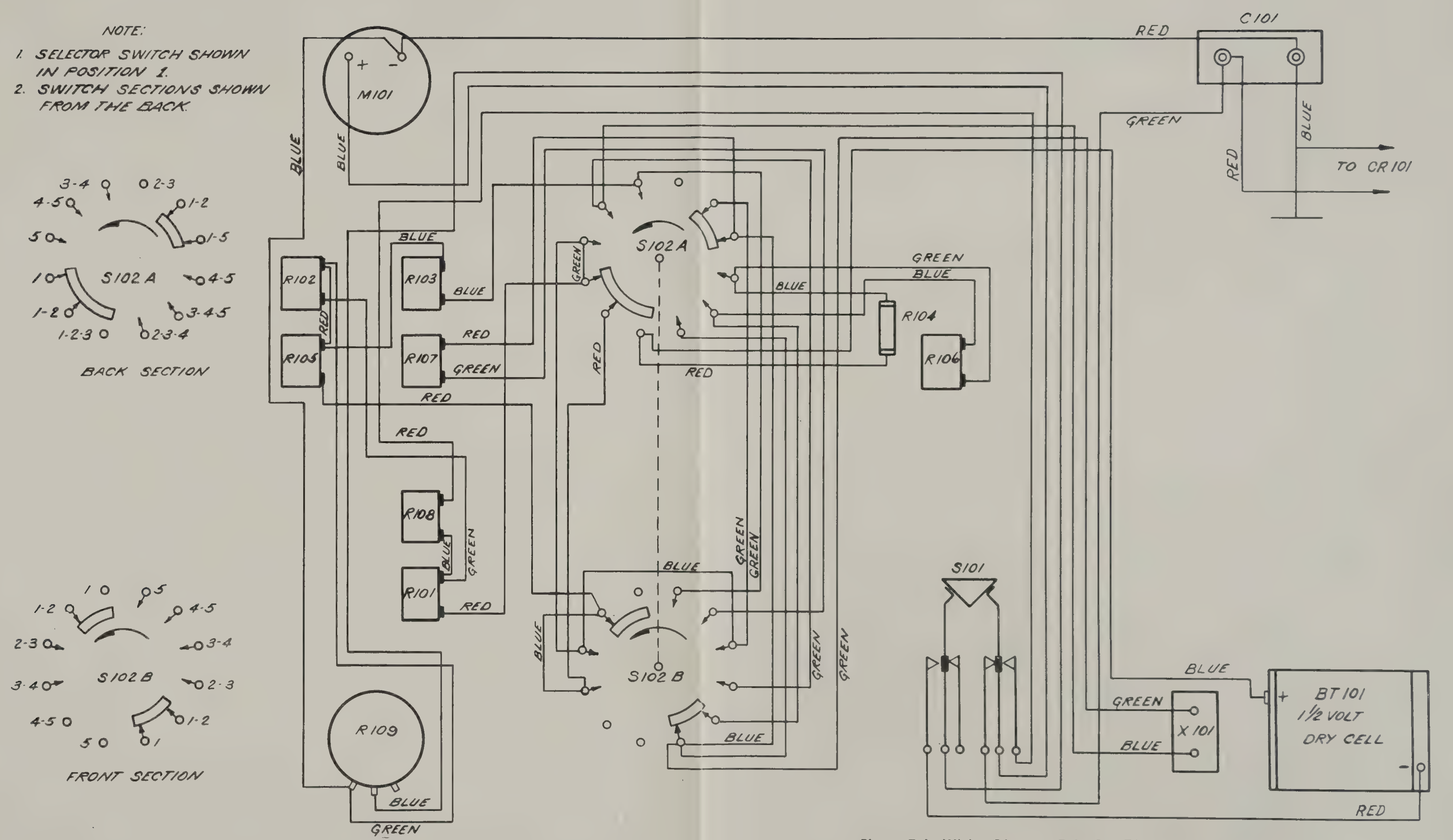


Figure 7-6. Wiring Diagram Echo Box TS-311B/UP

TABLE 8-1. WEIGHTS AND DIMENSIONS OF SPARE PARTS BOX

EQUIPMENT SPARES				
OVERALL DIMENSIONS			VOLUME	WEIGHT
HEIGHT	WIDTH	DEPTH		

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

TABLE 8-2. SHIPPING WEIGHTS AND DIMENSIONS OF SPARE PARTS BOX

EQUIPMENT SPARES				
OVERALL DIMENSIONS			VOLUME	WEIGHT
HEIGHT	WIDTH	DEPTH		

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

TABLE 8-3. LIST OF MAJOR UNITS

QUANTITY	NAME OF MAJOR UNIT	NAVY TYPE	DESIGNATION
1	Echo Box	TS-311B/UP	Radar Tester

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

TABLE 8-4. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
A-101	Shop Manufacture	Plate, crank bearing; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, ¾″ lg. x ⅜″ wide, clear anodized. J. S. Co. Part No. 31101.	To hold crank bearing
A-102	Shop Manufacture	Bracket, sliding; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, L-shaped, black anodized. J. S. Co. Part No. 31095.	To mount stop nut
A-103	Shop Manufacture	Plate, index; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, 2-1/16″ x 2″ overall, engraved index lines, black anodized, lines filled with White filler. J. S. Co. Part No. 31104.	To indicate dial reading
A-104	Shop Manufacture	Plunger assembly; consists of tube, bronze alloy No. 1012, 13/16″ O.D. x 37/64″ I.D. x 2-7/32″ lg., with disc., brass, ½ hard, 3¼″ dia. x 5/32″ thick. Silver soldered together, silver plated. J. S. Co. Part No. 31105-SA.	Plunger
A-105	Shop Manufacture	Bracket, head; 3/32″ thick sheet aluminum alloy No. 52S-H32, L-shaped, black anodized. J. S. Co. Part No. 31109.	Support head casting assembly
A-106	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Head casting assembly; aluminum casting alloy No. 195, 4-5/16″ O. D. 6 shoulder bushings and 1 center bushing pressed into casting, clear anodized and gray navy enameled. J. S. Co. Part No. 31131-SA.	To cover front end of cylinder
A-107	Shop Manufacture	Panel, sub; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, 4-13/16″ lg. x 3½″ wide x ¼″ deep, black anodized. J. S. Co. Part No. 31141.	To mount dial and index plate
A-108	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Crystal unit, wave guide; brass casting alloy No. 10, irregular shape, silver plated. J. S. Co. Part No. 31149-SA.	Echo Box output
A-109	Shop Manufacture	Plate, bearing block; No. 14 B. & S. sheet brass ½ hard, ¾″ lg. x ⅜″ wide, zinc plated and clear iridite dipped. J. S. Co. Part No. 31151.	To mount bearing block
A-110	Shop Manufacture	Plate wave guide; No. 14 B. & S. strip brass ½ hard, 1″ lg. x 13/16″ wide, silver plated. J. S. Co. Part No. 31158.	To close wave guide

A-111	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Cylinder assembly; brass, 3-5/16″ dia. bore, $11\frac{3}{8}$″ long, silver plated on interior surface, zinc chromate and gray navy enameled on exterior surface. J. S. Co. Part No. 31171-SA.	Resonant cavity
A-112	Shop Manufacture	Bracket, end; 3/32″ thick aluminum alloy No. 52S-H32, 3″ x $2\frac{7}{8}$″ x 2″ overall, black anodized. J. S. Co. Part No. 31176.	To mount C-101 and support base plate
A-113	For Reference Only	Cabinet case; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, 16″ lg. x 8″ wide x $7\frac{1}{4}$″ high, clear anodized and light gray navy enameled. With 4 captive nuts, brass $\frac{1}{2}$ hard, 5/16″ sq. x $\frac{3}{8}$″ lg., No. 10-24 thread, zinc plated and clear iridite dipped, gray navy enameled. J. S. Co. Part No. 31236.	To house Echo Box
A-114	For Reference Only	Cabinet cover; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, 16″ lg. x 8″ wide x 2-13/16″ high, clear anodized, light gray navy enameled. J. S. Co. Part No. 31239.	To house Echo Box
A-115	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Plate, base; aluminum casting alloy No. 195, 4-5/16″ dia. by 3/16″ thick, clear anodized, gray navy enameled. J. S. Co. Part No. 31253.	Cover rear end of cylinder
A-116	Shop Manufacture	Plate, locking; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, 1/16″ x 2″ x $2\frac{1}{2}$″ overall, black anodized. J. S. Co. Part No. 31257.	To lock side adjusting screws
A-117	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Plate, disc; brass casting alloy No. 10, 3-7/32″ dia. x 3/32″ thick, silver plated. J. S. Co. Part No. 31258.	Rear cylinder plate
A-118	Shop Manufacture	Transducer unit; brass cutting alloy No. 10, $1\frac{1}{2}$″ x $1\frac{1}{8}$″ O.A., silver plated. J. S. Co. Part No. 31265.	Input to Echo Box
A-119	Shop Manufacture	Nut, battery cap; brass, $\frac{1}{2}$ hard, $1\frac{7}{8}$″ dia. x $\frac{1}{2}$″ high, $1\frac{3}{4}$″-16 female thread 5/16″ deep. Zinc plated and clear iridite dipped. J. S. Co. Part No. 31278.	Cover for BT-101
A-120	For Reference Only	Chassis, sub; No. 14 B. & S. sheet aluminum alloy No. 52S-H32, $5\frac{3}{8}$″ lg. x $2\frac{7}{8}$″ wide x $1\frac{3}{8}$″ deep, black anodized, printed numerals. J. S. Co. Part No. 31284.	Mounting crystal checker network
A-121	For Reference Only	Panel, front; 3/32″ thick sheet aluminum alloy No. 52S-H32, $15\frac{1}{4}$″ lg. x $7\frac{3}{4}$″ wide x 11/32″, with 4 bushings staked in, clear anodized, light gray enamel and white screened letters. J. S. Co. Part No. 31285.	To mount Echo Box

DESIGNATION REFERENCE	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
A-122	Shop Manufacture	Window, 1/16″ thick clear plexiglass, 3-17/32″ lg. x 3″ wide. J. S. Co. Part No. 31287.	To view dials
A-123	Shop Manufacture	Bracket, stop; No. 14 B. & S. sheet brass, ½ hard, ¾″ lg. x ⅞″ wide x 9/16″ high, zinc plated and clear iridite dipped. J. S. Co. Part No. 31290.	Stop for meter sensitivity dial
A-124	Shop Manufacture	Bumpers, rubber; 15/16″ dia. x ½″ high, No. 8 steel washer insert. J. S. Co. Part No. SPC-12816.	Cabinet mountings
A-125	2Z1619-14 Shop Manufacture 3300-286688650	Nut, cap; brass, 1-1/16″ dia. x 5/16″ high, 15/16″-18 female thread, 7/32″ deep, zinc plated and clear iridite dipped. J. S. Co. Part No. 24808.	Cap for crystal holder
A-126	For Reference Only	Holder, spare crystal: brass, ½ hard, 1¼″ x 1¼″ x 15/16″ lg., 15/16″-18 male thread, ¼″ deep, one end, zinc plated and clear iridite dipped. J. S. Co. Part No. 31548-SA.	To hold spare crystals
BT-101	N17-B-150001-149	Case, battery; empty, insurok grade T-643 body, 1-13/32″ dia. hole drilled through plate. Brass, ½ hard, zinc plated and clear iridite dipped on one end. Bushing; brass ½ hard, zinc plated and clear iridite dipped, 1¾″-16 thread, ⅜″ deep on other end. O.A. dimensions, 1-15/16″ x 1⅞″ x 3″. J. S. Co. Part No. SA-18265.	Case to hold battery
C-101	For Replacement Use N16-C-47297-3175	Capacitor; fixed paper dielectric oil impregnated. .5 MFD ±15%, 600 VD CW Spec. JAN-C-25. J. S. Co. Part No. SPC-12805.	Capacitor shunt for M-101
CR-101	N16-T-51723-10	Crystal unit, rectifying; JAN-IN23B detector type, porcelain body with brass fittings. 27/32″ lg. x 19/64″ max. dia. J. S. Co. Part No. SPC-12770.	Rectifier
E-101	N16-A-52545-1626	Horn, antenna; AT-68/UP assembly consists of pick-up horn aluminum casting alloy No. 100-4, .093″ wall thick, 3-23/64″ lg. x 1⅛″ wide x 1-5/16″ high, clear anodized and gray navy enamel exterior surfaces. Tube; brass, ½ hard, ⅝″ dia. x 1-15/64″ lg. silver plated and rhodium plate flash. Bead; polystyrene, 15/32″ dia. x 5/16″ lg. Probe; beryllium copper, ½ hard, ⅛″ dia. x 1-7/16″ lg., heat treated, silver plated, rhodium plate flash. Assembly cemented together. J. S. Co. Part No. SA-18266.	Antenna

E-102	Shop Manufacture	Plunger disc; laminated phenolic sheet type XXX paper base, 3-3/16" dia. x $\frac{3}{8}$" thick. J. S. Co. Part No. 31107.	Dampener for A-104
E-103	Shop Manufacture	Insulator, bushing; black bakelite, 3/16" dia. x 3/32" lg. J. S. Co. Part No. 31161.	Insulator for screws
E-104	Procured On Demand By Nearest Naval Shore Supply Activity	Knob, tuning; black bakelite, $1\frac{3}{8}$" dia. x $\frac{7}{8}$" height, $1\frac{1}{2}$" skirt dia., no index line, brass insert for $\frac{1}{4}$" shaft, 2 Allen socket set screws. J. S. Co. Part No. SPC-12840.	Tuning adjustment
E-105	Procured On Demand By Nearest Naval Shore Supply Activity	Knob, meter adjusting; black bakelite, $1\frac{1}{8}$" dia. x $\frac{5}{8}$" height, brass insert for $\frac{1}{4}$" shaft, 2 Allen socket set screws. J. S. Co. Part No. SPC-12839.	Adjusting M-101
E-106	Procured On Demand By Nearest Naval Shore Supply Activity	Knob, meter sensitivity; black bakelite, $1\frac{1}{8}$" dia. x $\frac{5}{8}$" height, $\frac{7}{8}$" long pointer, brass insert for $\frac{1}{4}$" shaft, 2 Allen socket set screws. J. S. Co. Part No. SPC-12838.	Adjusting sensitivity of M-101
E-107	Procured On Demand By Nearest Naval Shore Supply Activity	Knob, crystal checker pointer; black molded plastic with white index lines, $1\frac{1}{2}$" long x $\frac{7}{8}$" high, brass insert for $\frac{1}{4}$" shaft, No. 10-32 Allen set screw. J. S. Co. Part No. SPC-12993.	Adjusting crystal checker
H-101	G41-W-2445	Wrench, Allen; for No. 6 screw, L-shaped of 1/16" hex steel rod, zinc plated, 1-27/32" long leg, 21/32" short leg. J. S. Co. Part No. SPC-11799.	Tool
H-102	G41-W-2446	Wrench, Allen; for No. 8 screw, L-shaped of 5/64" hex steel rod, zinc plated, $1\frac{7}{8}$" long leg, 11/16" short leg. J. S. Co. Part No. SPC-11773.	Tool
H-103	G41-W-2449	Wrench, Allen; for No. 10 screw, L-shaped of 3/32" hex steel rod, zinc plated, $2\frac{1}{8}$" long leg, $\frac{3}{4}$" short leg. J. S. Co. Part No. SPC-9630.	Tool
H-104	Shop Manufacture	Washer, spring tension; No. 30 B. & S. phosphor bronze, spring temper, 13/32" O.D. x .255" I.D. x .025" dish. J. S. Co. Part No. 28963.	To load O-108
H-105	Shop Manufacture	Washer, flat; No. 27 B. & S. phosphor bronze, spring temper, $\frac{1}{2}$" O.D. x .255" I.D. J. S. Co. Part No. 31094.	Spacer

REFERENCE DESIGNATION	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
H-106	Shop Manufacture	Nut, stop; brass ½ hard, ⅞″ lg. x ⅝″ wide x ¼″ thick, No. 4-40 thread, zinc plated and clear iridite dipped, with pin, No. 34 drill rod size, phosphor bronze, hard, ⅜″ long, zinc plated and clear iridite dipped, pressed into nut. J. S. Co. Part No. 31097.	Mounts on O-109
H-107	Shop Manufacture	Washer, flat; No. 17 B. & S. phosphor bronze, ½ hard, 15/32″ O.D. x .253″ I.D., zinc plated and clear iridite dipped. J. S. Co. Part No. 31098.	Spacer
H-108	Shop Manufacture	Pin, wrist; .1875″ dia. stainless steel, type 303, centerless ground, .723″ long. J. S. Co. Part No. 31099.	To hold O-104 & A-104 together
H-109	Shop Manufacture	Spacer, wrist pin; brass ½ hard, 5/16″ O.D. x .189″ I.D. x .073″ thick, zinc plated and iridite dipped. J. S. Co. Part No. 31114.	Spacer for O-104
H-110	Shop Manufacture	Washer, friction; No. 27 B. & S. phosphor bronze, spring temper, ⅜″ O.D. x .189″ I.D. x 3/64″ dish. J. S. Co. Part No. 4952.	To load O-110 & O-111
H-111	Shop Manufacture	Washer, flat; No. 25 U.S.S. stainless steel, type 303, ⅜″ O.D. x .257″ I.D. J. S. Co. Part No. 31145.	Spacer for O-115
H-112	Shop Manufacture	Nut, clamping; cold rolled steel, ¾″ dia. x ⅛″ thick, No. 10-32 thread, zinc plated and clear iridite dipped. J. S. Co. Part No. 31254.	To lock H-114 & A-115 together
H-113	Shop Manufacture	Screw, center adjusting; phosphor bronze; ½ hard, .339″ max. dia. x 1″ long, No. 10-32 thread, silver plated. J. S. Co. Part No. 31260.	To adjust A-117
H-114	Shop Manufacture	Screw, side adjusting; stainless steel, type 303, 5/16″ max. dia. x 15/16″ long, No. 10-32 thread. J. S. Co. Part No. 31261.	To adjust A-117
H-115	Shop Manufacture	Spacer, sub-panel; aluminum alloy 17-ST, 7/16″ O.D. x .182″ I.D. x 9/16″ lg., clear anodized. J. S. Co. Part No. 31286.	Spacer for A-107

H-116	Shop Manufacture	Handle, panel; $\frac{1}{4}''$ dia. aluminum alloy No. 52S-H34, U-shaped, $5\frac{3}{8}''$ lg. x 1″ wide, O.A., No. 8-32 tapped hole on each bent end, clear anodized and gray navy enameled. J. S. Co. Part No. 31289.	Handle for A-121
H-117	Shop Manufacture	Screw, captive; stainless steel, type 303, 7/16″ max. dia. x $1\frac{3}{8}''$ lg., No. 10-24 thread. J. S. Co. Part No. 31297.	To secure A-121
H-118	Shop Manufacture	Nut, ferrule; brass, $\frac{1}{2}$ hard, $\frac{1}{2}''$ hex x $\frac{1}{8}''$ thick, 7/16″-28 thread, silver plated. J. S. Co. Part No. 31270.	Used with W-102
H-119	Shop Manufacture	Handle, cabinet; $\frac{1}{2}''$ dia. aluminum alloy No. 52S-H34, U-shaped, $5\frac{1}{4}''$ lg. x $2\frac{1}{4}''$ wide O.A., clear anodized, gray navy enameled. J. S. Co. Part No. 31303.	To carry A-113 & A-114
H-120	Shop Manufacture	Stud assembly; $\frac{1}{2}''$ dia. aluminum alloy No. 52S-H32, 1-5/32″ long irregular shape, $\frac{1}{4}''$-20 thread on end, clear anodize. With pin; brass $\frac{1}{2}$ hard, 3/16″ max. dia. x 17/32″ long, zinc plated and clear iridite dipped, pin staked in. J. S. Co. Part No. 31305-SA.	To mount H-119
H-121	Shop Manufacture	Spacer, sub-chassis; aluminum alloy 17-ST, 5/16″ O.D. x .147″ I.D. x 5/32″ lg., clear anodized. J. S. Co. Part No. 31310.	Spacer for A-120
H-122	Procured On Demand By Nearest Naval Shore Supply Activity	Retaining ring; for $\frac{1}{4}''$ shaft, zinc plated and clear iridite dipped. J. S. Co. Part No. SPC-11181.	To retain O-117
H-123	Shop Manufacture	Panel bushing with nut; for $\frac{1}{4}''$ shaft, 7/16″ overall length with $\frac{1}{2}''$ hex, 1/16″ thick and $\frac{3}{8}''$-32 thread, nickel or cadmium plated. J. S. Co. Part No. SPC-12850.	To support O-125
H-124	Procured On Demand By Nearest Naval Shore Supply Activity	Clip, single fahnestock; brass, 1-7/16″ long, $\frac{3}{8}''$ wide, $\frac{1}{4}''$ hole. J. S. Co. Part No. SPC-12815-ZN-1.	Hold Allen socket wrenches
H-125	Shop Manufacture	Washer, flat; fibre, $\frac{3}{8}''$ O.D. x .150″ I.D. x 1/32″ thick. J. S. Co. Part No. 1271-FB.	Insulate resistors
H-126	Shop Manufacture	Spacer; brass, $\frac{7}{8}''$ O.D. x 13/32″ I.D. x 1/16″ thick. J. S. Co. Part No. 9319.	Spacer for A-120

REFERENCE DESIGNATION	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
H-127	Shop Manufacture	Washer, flat; stainless steel, type 303, 3/8″ O.D. x .140″ I.D. x 1/16″ thick. J. S. Co. Part No. 31809.	To retain O-117
H-128	Shop Manufacture	Screw, shoulder; brass 1/2 hard, 1/4″ max. dia. x 3/8″ lg., No. 4-48 thread, zinc plated and clear iridite dipped. J. S. Co. Part No. 31123.	To lock O-110 & O-111
J-101	——— N17-C-73108-6065	Connector, plug; JAN UG-19B/U, female contact, brass, silver plated. Used with RG-5/U cable. J. S. Co. Part No. SPC-13181.	Used with W-102
M-101	——— N17-M-21878-2376	Meter, D.C.; range 54 millivolts in 1500 ohm circuit, round plastic flush mounted case, 3 1/2″ dia. flange, 2 3/4″ dia. body, 1″ deep behind flange. Accuracy 5% of full scale. Resistance 1500 ohms ±20%. Scale 0-10 kilohms and 0-1 MA black numerals on white background. Red and green blocks marked good and poor. Scale angle 40°. Three 5/32″ mounting holes equally spaced on 3-3/16″ dia. B.C. Two stud terminals 1/4″-28 x 3/4″ lg. on 1-13/32″ centers. J. S. Co. Part No. SPC-12800.	Tuning Indicator
N-101	Shop Manufacture	Dial, vernier; No. 18 B. & S. aluminum alloy No. 52S-H39, 3 1/4″ O.D., engraved, black anodized, lines filled with white filler. J. S. Co. Part No. 31122.	Tuning Echo Box
N-102	Shop Manufacture	Dial, drum; No. 18 B. & S. aluminum alloy No. 52S-0, 4 1/4″ O.D. x 9/16″ deep, engraved, black anodized, lines filled with white filler. J. S. Co. Part No. 31132.	Tuning Echo Box
N-103	For Reference Only	Name plate; for contract NObsr-52618. J. S. Co. Part No. 31307.	Identification
O-101	Shop Manufacture *	Spring, spiral compression; No. 14 B. & S. phosphor bronze wire, spring temper, 1-3/16″ O.D. at base, 5/16″ O.D. at top, 3/4″ free length, 4 coils, zinc plated and olive drab iridite dipped. J. S. Co. Part No. 6468.	Used with BT-101
O-102	Shop Manufacture *	Spring, flat; No. 32 B. & S. phosphor bronze, spring temper, zinc plated and clear iridite dipped. J. S. Co. Part No. 31110.	To guide H-106

* Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

O-103	Shop Manufacture	Collar, tuning shaft; brass, ½ hard, ½″ dia. x 3/16″ thick, zinc plated and clear iridite dipped. J. S. Co. Part No. 31096.	To secure O-109
O-104	Shop Manufacture	Connecting rod; aluminum alloy No. 52S-H32, 2⅝″ lg. x ⅜″ wide x ½″ thick, clear anodized. J. S. Co. Part No. 31100.	To move A-104
O-105	Shop Manufacture	Bearing, crank; brass, ½ hard, ⅝″ lg. x ⅜″ wide x 5/16″ thick, zinc plated and clear iridite dipped. J. S. Co. Part No. 31102.	Connect O-104 to O-113
O-106	Shop Manufacture	Hub, dial; aluminum alloy No. 52S-H32, 1⅝″ dia. x ½″ thick, clear anodized. J. S. Co. Part No. 31103.	To secure N-101 & N-102
O-107	Shop Manufacture	Boss, spring; aluminum alloy No. 52S-F, 1⅜″ dia. x ⅝″ thick, clear anodized. J. S. Co. Part No. 31113.	To retain O-131
O-108	Shop Manufacture	Collar, stop; brass ½ hard, ½″ dia. x 3/16″ thick. With stop; brass, No. 14 B. & S. ½ hard, 7/32″ x 3/16″, silver soldered to collar, zinc plated and clear iridite dipped. J. S. Co. Part No. 31119.	To limit movement of O-109
O-109	Shop Manufacture	Shaft, worm gear and dial; stainless steel, type 303, ⅜″ dia. x 5⅞″ long, ⅜″-24 thread. J. S. Co. Part No. 31120.	To tune plunger
O-110	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Piston gear assembly; consists of 1 pair matched gears, No. 8 B. & S. brass, ¾ hard, based on full 360° gear, 144 teeth, 48 pitch, 3.000″ P.D., 3.040″ O.D. Locating pin; brass ½ hard, 3/16″ dia. x ¼″ overall length, zinc plated and clear iridite dipped. Holding pin; No. 59 drill size brass rod, .040″ dia. x 15/64″ long. J. S. Co. Part No. TA-18259.	To drive A-104
O-111	Low-Failure Item — If Required, Requisition from ESO Referencing NAVSHIPS 900,180A	Dial gear assembly; consists of 1 pair matched gears, No. 8 B. & S. brass, ¾ hard, based on full 360° gear, 180 teeth, 48 pitch, 3.750″ P.D., 3.790″ O.D. Locating pin; brass, ½ hard, 3/16″ dia. x ¼″ overall length, zinc plated and clear iridite dipped. Holding pin; No. 59 drill size brass rod, .040″ dia. x 15/64″ long. J. S. Co. Part No. TA-18260.	To rotate N-102
O-112	Shop Manufacture	Shaft, drum dial; stainless steel, type 303, centerless ground, .250″ dia. x 2¼″ long. J. S. Co. Part No. 31124.	To support N-102

REFERENCE DESIGNATION	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
O-113	Shop Manufacture	Crank; brass ½ hard, 13/16″ lg. x ½″ wide x 5/16″ thick, zinc plated and clear iridite dipped. With pin; .1875″ dia. stainless steel, type 303, centerless ground, ⅞″ long. J. S. Co. Part No. 31126.	To transmit motion to O-104
O-114	Shop Manufacture	Gear, worm; stainless steel, Type 303, single thread 48 pitch, .500″ P.D., .541″ O.D. J. S. Co. Part No. 31127.	To rotate O-110
O-115	Shop Manufacture	Gear, pinion; brass ½ hard, 30 teeth, 48 pitch, .625″ P.D., .666″ O.D. J. S. Co. Part No. 31128.	Engages O-111
O-116	Shop Manufacture	Shaft, crank; stainless steel, type 303, centerless ground, .250″ dia. x 3-5/16″ long. J. S. Co. Part No. 31130.	To support O-113
O-117	Shop Manufacture	Shaft, pinion gear; stainless steel, type 303, centerless ground, .250″ dia. x 2¾″ long. J. S. Co. Part No. 31144.	To transmit motion to O-122
O-118	Shop Manufacture	Block, pinion shaft bearing; brass ½ hard, ¾″ lg. x ⅝″ wide x ⅜″ thick, zinc plated and clear iridite dipped. J. S. Co. Part No. 31147.	To support O-117
O-119	Shop Manufacture	Shaft, attenuator; stainless steel, type 303, centerless ground, .250″ dia. x 1-9/16″ long. J. S. Co. Part No. 31148.	To support O-122 and R-110
O-120	Shop Manufacture *	Retainer; brass ½ hard, 9/16″ max. dia. x 15/32″ long, ⅜″-32 thread, silver plated. J. S. Co. Part No. 31153.	To retain CR-101
O-121	Shop Manufacture *	Extractor; brass ½ hard, ¾″ max. dia. x 37/64″ long, ½″-28 thread, silver plated. J. S. Co. Part No. 31154.	To extract CR-101

* Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

O-122	Shop Manufacture	Gear, sensitivity control spur; brass ½ hard, 56 teeth, 48 pitch, 1.167″ P.D., 1.175″ O.D. J. S. Co. Part No. 31159.	To rotate R-110
O-123	Shop Manufacture	Gear, sensitivity control pinion; brass ½ hard, 12 teeth, 48 pitch, .250″ P.D., .292″ O.D. J. S. Co. Part No. 31160.	To rotate O-122
O-124	Shop Manufacture	Collar, stop; brass ½ hard, ⅝″ dia. x 5/16″ thick, zinc plated and clear iridite dipped. With pin; brass ½ hard, 5/32″ dia. x 5/16″ long, zinc plated and clear iridite dipped, pressed into collar. J. S. Co. Part No. 31173.	Limits rotation of O-125
O-125	Shop Manufacture	Shaft, tuning; stainless steel, type 303, ¼″ dia. x 2-5/32″ long. J. S. Co. Part No. 31175.	To engage E-106 to O-130
O-126	Shop Manufacture	Bushing, panel handle; aluminum alloy No. 17S-H32, ⅝″ dia. x ⅜″ thick, clear anodized, gray navy enameled. J. S. Co. Part No. 31296.	To mount H-116
O-127	Shop Manufacture	Post, antenna horn locking; brass ½ hard, 9/16″ dia. x 11/16″ long, zinc plated and clear iridite dipped. J. S. Co. Part No. 31301.	To store E-101
O-128	Shop Manufacture	Nut, antenna locking post; brass ½ hard, ¾″ dia. x ⅝″ long, ⅝″-24 thread, zinc plated and clear iridite dipped. J. S. Co. Part No. 31302.	To store E-101
O-129	Shop Manufacture	Post, antenna cable locking; brass ½ hard, ⅝″ dia. x 13/16″ long, ⅝″-24 thread, zinc plated and clear iridite dipped. J. S. Co. Part No. 31306.	To store W-101
O-130	N16-C-99999-0392	Coupling, flexible; ceramic insulation with hubs, inside of spring arms for ¼″ shaft. With 4 headless Allen set screws (cup point), cadmium plated. J. S. Co. Part No. SPC-12792.	To connect O-117 to O-125
O-131	Shop Manufacture	Spring helical compression; No. 12 B. & S. phosphor bronze wire, spring temper, 1-3/16″ I.D., 3⅝″ free length, 9 coils, silver plated. J. S. Co. Part No. 6465.	To load A-104
O-132	Shop Manufacture	Spring, helical compression; .042″ dia. carbon steel wire, ⅜″ O.D., ⅝″ free length, 6½ coils, stress relief anneal before plating, zinc plated and olive drab iridite dipped. J. S. Co. Part No. 6466.	To load A-117

REFERENCE DESIGNATION	STOCK NUMBERS — SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
O-133	Shop Manufacture	Spring, helical compression; .048″ dia. carbon steel wire, spring temper, 5/16″ O.D. 5/8″ free length, 6 coils, stress relief anneal before plating, zinc plated and olive drab iridite dipped. J. S. Co. Part No. 6467.	To load A-117
O-134	Shop Manufacture	Spring, helical compression; .030″ dia. stainless steel spring wire, 7/32″ I.D., 13/16″ free length, 10½ coils, stress relief after fabrication. J. S. Co. Part No. 6469.	To load O-110 & O-111
O-135	Shop Manufacture	Ferrule; brass ½ hard, 7/16″ dia. x 1-5/16″ long, 5/16″-32 thread, 7/16″-28 thread, silver plate. J. S. Co. Part No. 31269.	Used with W-102
P-101	2Z7390-21B N17-C-71417-9699 8800-467462	Connector, plug; UG-21B/U male contact, brass, silver plated. Used with RG-9A/U cable. J. S. Co. Part No. SPC-11775.	Used with W-101
R-101	N16-R-99999-0196	Resistor; fixed wire wound, 46 ohm ±1%, ½ watt, ½″ dia. x 9/16″ long, soldering lug terminals. J. S. Co. Part No. SPC-12825.	Voltage dropping resistor
R-102	N16-R-99999-0195	Resistor; fixed wire wound, 55.1 ohm ±1%, ½ watt, ½″ dia. x 9/16″ long, soldering lug terminals. J. S. Co. Part No. SPC-12820.	Voltage dropping resistor
R-103	N16-R-78909-2401	Resistor; fixed wire wound, 100 ohm ±1%, ½ watt, ½″ dia. x 9/16″ long, soldering lug terminals. J. S. Co. Part No. SPC-12827.	Voltage dropping resistor
R-104	N16-R-49579-431	Resistor; fixed carbon 100 ohm ±5%, ½ watt, .140″ dia. x .375″ long, .033″ axial leads, ½″ long. JAN-RC20BF101J. J. S. Co. Part No. SPC-12826.	Voltage dropping resistor
R-105	N16-R-99999-0194	Resistor; fixed wire wound 300 ohm ±1%, ½ watt, ½″ dia. x 9/16″ lg., soldering lug terminals. J. S. Co. Part No. SPC-12821.	Voltage dropping resistor
R-106	N16-R-99999-0193	Resistor; fixed wire wound 600 ohm ±1%, ½ watt, ½″ dia. x 9/16″ lg., soldering lug terminals. J. S. Co. Part No. SPC-12823.	Voltage dropping resistor

R-107	N16-R-99999-0192	Resistor; fixed wire wound 900 ohm ±1%, 1 watt, ½″ dia. x 9/16″ lg., soldering lug terminals. J. S. Co. Part No. SPC-12822.	Voltage dropping resistor
R-108	N16-R-99999-0191	Resistor; fixed wire wound 1500 ohm ±1%, ½ watt, ½″ dia. x 9/16″ lg., soldering lug terminals. J. S. Co. Part No. SPC-12824.	Voltage dropping resistor
R-109	N16-R-90493-8400	Potentiometer; wire wound linear 0-500 ohm ±10%, 2 watt, standard ¼″ shaft, ⅜″-32 mounting stud, soldering lug terminals. JAN-RA20AFE501AK. J. S. Co. Part No. SPC-12817.	Voltage dropping resistor
R-110	N16-A-99999-0400	Attenuator; No. 24 B. & S. brass ½ hard, 1-1/32″ x 53/64″ x ⅛″ O.A., silver plated. J. S. Co. Part No. 31152.	Resistive loading device
R-111	N16-R-99999-0190	Resistor, Element; 110 ohms per sq. inch resistance material, 1.240″ long x .500″ wide x 1/32″. J. S. Co. Part No. 31162.	Voltage dropping resistor
S-101	N17-S-58904-3561	Switch, push; double pole, double throw, 3 amp., 125 volts, ⅜″-32 mounting stud, soldering lug terminals, black bakelite push button, non-locking, nickel or cadmium plated. J. S. Co. Part No. SPC-12819.	Crystal testing switch
S-102	N17-S-99999-0161	Switch, rotary; 1 section, 2 pole, 5 position ceramic wafers, soldering lug terminals, 3/32″-32 mounting bushing, O.A. dimensions approx. 2″ dia. x 2-1/16″ long. J. S. Co. Part No. SPC-12818.	Crystal checker switch
W-101	N16-C-11616-1621	Cable assembly, RF; use AN cable RG-9A/U, 7′-10″ ±3″ lg. excluding terminations, 8′-0″, ±3″ lg. overall. AN connector, male contact UG-21B/U (P-101) on each end. J. S. Co. Part No. SPC-12799.	RF input connect
W-101A	N15-C-12200-525	Cable, RF; AN Type RG-9A/U. J. S. Co. Part No. SPC-12627.	Bulk Cable
W-102	N15-C-99999-0393	Cable assembly, RF; use AN cable RG-5/U, 12-7/16″ ±⅛″ lg. excluding terminations, 13″ ±⅛″ lg. overall. AN connector, female contact UG-19B/U (J-101) on one end. Ferrule nut (H-118) and ferrule (O-135) on other end. J. S. Co. Part No. SPC-12882.	Tuned and untuned input connector
W-102A	N15-C-12200-0900	Cable, RF; AN Type RG-5/U. J. S. Co. Part No. SPC-8763.	Bulk Cable

REFERENCE DESIGNATION	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
X-101	N16-S-99999-0160	Socket assembly, crystal; consists of body, brass ½ hard, .012″ dia. x .519″ lg., with clutch, beryllium copper, ½ hard, 3/16″ dia. x .781″ lg. silver soldered together, heat treated and silver plated. J. S. Co. Part No. 31156-SA.	To retain crystal in A-108
X-102	N16-H-99999-0019	Crystal test holder; black bakelite base, two phosphor bronze wire contacts, one 5/32″ mounting hole, O.A. 1″ lg. x 9/16″ wide x ½″ thick, contacts ½″ long. J. S. Co. Part No. SPC-12851.	To hold crystal for test
X-103	Fabricate * Locally From Bulk Material, SNSNG17-I-3340	Socket, dielectric; .003″ thick sheet mica, .812″ dia. J. S. Co. Part No. 31157.	Insulator between A-108 and X-101

* Not furnished as a maintenance part. If failure occurs, do not request replacement unless the item cannot be repaired or fabricated.

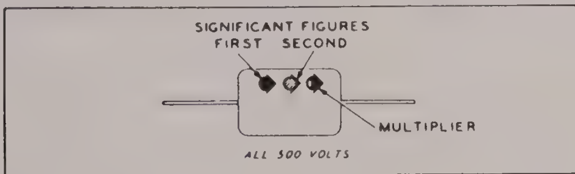
TABLE 8-5. CROSS REFERENCE PARTS LIST

JAN (or AWS) DESIGNATION	KEY SYMBOL	NAVY TYPE	KEY SYMBOL	ARMY - NAVY TYPE NO.	KEY SYMBOL	FEDERAL STOCK NO.	KEY SYMBOL	ITEM NO.	KEY SYMBOL
AT-68/UP	E-101	—22547	M-101						
CG-92B/U(8)	W-101								
CP53B1DF504L	C-101								
				FEDERAL STOCK NO.	**KEY SYMBOL**				
RA20A1FE501AK	R-109								
RB12A46R10F	R-101								
						SIGNAL CORPS STOCK NO.	**KEY SYMBOL**		
RB12A55R10F	R-102								
RB12A100R0F	R-103								
RB12A300R0F	R-105								
RB12A600R0F	R-106								
		ARMY - NAVY TYPE NO.	**KEY SYMBOL**						
RB12A900R0F	R-107								
RB12A1500R0F	R-108								
RG20BF101J	R-104								
IN23B	CR-101								
UG-19B/U	J-101								
UG-21B/U	P-101								

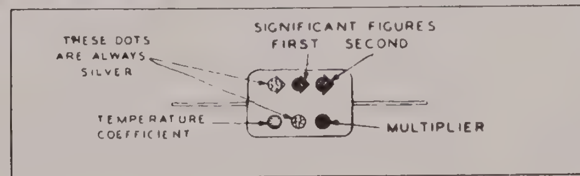
TABLE 8-6. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

CAPACITOR COLOR CODES

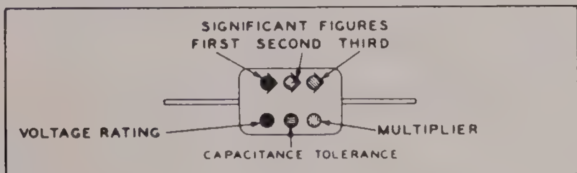
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



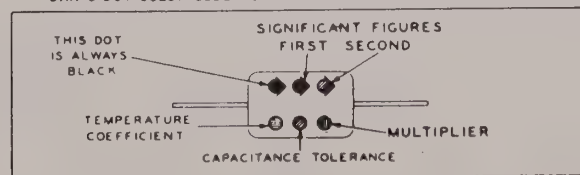
JAN 6-DOT COLOR CODE FOR PAPER DIELECTRIC CAPACITORS



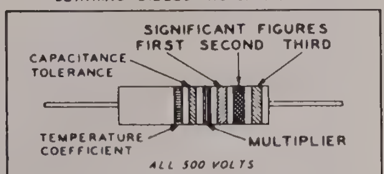
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

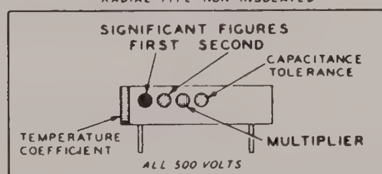


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

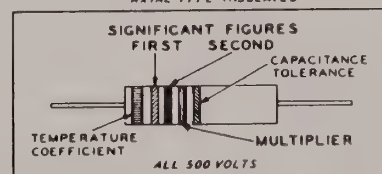


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



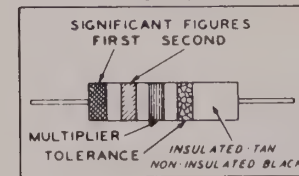
RMA. RADIO MANUFACTURERS ASSOCIATION
JAN. JOINT ARMY-NAVY

RESISTORS			CAPACITORS					
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	MULTIPLIER: RMA MICA AND CERAMIC-DIELECTRIC	MULTIPLIER: JAN MICA AND PAPER-DIELECTRIC	MULTIPLIER: JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

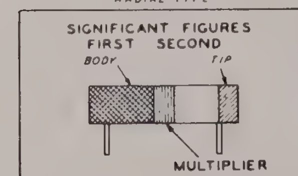
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

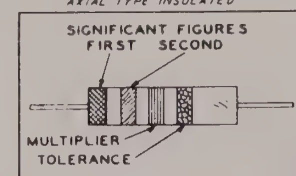


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

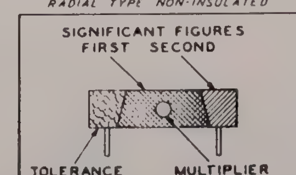


TABLE 8-7. LIST OF MANUFACTURERS

CODE NO.	MFGRS. PREFIX	NAME	ADDRESS
	CAM	Aerovox Corp.	New Bedford, Mass.
	CBZ	Allen Bradley Co.	Milwaukee, Wisconsin
	CAYT	Allen Mfg. Co.	Hartford, Conn.
		Allied Radio Co.	Chicago, Ill.
	CPH	American Phenolic Corp.	Chicago, Ill.
	CTC	Chicago Telephone & Supply Co.	Elkhart, Ind.
		Davis, Harry Molding Co.	Chicago, Ill.
		Fahnestock Elect. Co. Inc.	Long Island City, N. Y.
	CABV	Johnson Service Co.	Milwaukee, Wisconsin (2)
		Kurtz-Kasch Inc.	Dayton 1, Ohio
		Mallory, P. R. & Co. Inc.	Indianapolis, Ind.
		Millen, James Co.	Malden, Mass.
		Miller Electro Research Lab.	Milwaukee, Wisconsin
	COC	Oak Mfg. Co.	Chicago, Ill.
		Radio Frequency Lab.	Boonton, N. J.
		Sylvania Electric Prod. Inc.	New York, N. Y.
		Waldis Kohinoor, Inc.	Long Island City, N. Y.
		Western Rubber Co.	Goshen, Ind.
	CV	Weston Electrical Instr. Co.	Paterson, N. J.

RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ________________ SERIAL ____________ LOCATION __________

ECHO BOX TS-311B/UP, SERIAL __________ RADAR CONDITIONS:- PULSE LENGTH ______

TESTS MADE:- WITH DIRECTIONAL COUPLER ________________ REP. RATE __________

WITH TEST ANTENNA ________________ REC. BW. __________

LOCATION ________________________________ RINGTIME __________

DATE	TIME	OBSERVED RINGTIME	RADAR PERFORMANCE	RADAR METERS		CHECKED BY
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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ____________ SERIAL ____________ LOCATION ____________

ECHO BOX TS-311B/UP, SERIAL ____________ RADAR CONDITIONS:- PULSE LENGTH ____________

TESTS MADE:- WITH DIRECTIONAL COUPLER ____________ REP. RATE ____________

WITH TEST ANTENNA ____________ REC. BW. ____________

LOCATION ____________ RINGTIME ____________

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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ________________ SERIAL ____________ LOCATION __________

ECHO BOX TS-311B/UP, SERIAL __________ RADAR CONDITIONS:-PULSE LENGTH ______

TESTS MADE:-WITH DIRECTIONAL COUPLER ________________ REP. RATE __________

WITH TEST ANTENNA ______________________ REC. BW. __________

LOCATION ____ RINGTIME __________

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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ________ SERIAL ________ LOCATION ________

ECHO BOX TS-311B/UP, SERIAL ________ RADAR CONDITIONS:- PULSE LENGTH ________

TESTS MADE:- WITH DIRECTIONAL COUPLER ________ REP. RATE ________

WITH TEST ANTENNA ________ REC. BW. ________

LOCATION ________ RINGTIME ________

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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ________________ SERIAL ____________ LOCATION __________

ECHO BOX TS-311B/UP, SERIAL __________ RADAR CONDITIONS:-PULSE LENGTH ______

TESTS MADE:- WITH DIRECTIONAL COUPLER ________________ REP. RATE ________

WITH TEST ANTENNA ______________________ REC. BW. ________

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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ______________ SERIAL ______________ LOCATION ______________

ECHO BOX TS-311B/UP, SERIAL ______________ RADAR CONDITIONS:- PULSE LENGTH ______________

TESTS MADE:- WITH DIRECTIONAL COUPLER ______________ REP. RATE ______________

WITH TEST ANTENNA ______________ REC. BW. ______________

LOCATION ______________ RINGTIME ______________

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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ________________ SERIAL ____________ LOCATION __________

ECHO BOX TS-311B/UP, SERIAL __________ RADAR CONDITIONS:-PULSE LENGTH ______

TESTS MADE:- WITH DIRECTIONAL COUPLER ________________ REP. RATE __________

WITH TEST ANTENNA ______________________ REC. BW. __________

LOCATION ______________________________________ RINGTIME __________

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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ______________ SERIAL ______________ LOCATION ______________

ECHO BOX TS-311B/UP, SERIAL ______________ RADAR CONDITIONS:- PULSE LENGTH ______________

TESTS MADE:- WITH DIRECTIONAL COUPLER ______________ REP. RATE ______________

WITH TEST ANTENNA ______________ REC. BW. ______________

LOCATION ______________ RINGTIME ______________

DATE	TIME	OBSERVED RINGTIME	RADAR PERFORMANCE	RADAR METERS		CHECKED BY
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RADAR PERFORMANCE CHECK SHEET

RADAR MODEL ______________ SERIAL ______________ LOCATION ______________

ECHO BOX TS-311B/UP, SERIAL ______________ RADAR CONDITIONS:-PULSE LENGTH ______

TESTS MADE:-WITH DIRECTIONAL COUPLER ______________ REP. RATE ______

WITH TEST ANTENNA ______________ REC. BW. ______

LOCATION ______________ RINGTIME ______

DATE	TIME	OBSERVED RINGTIME	RADAR PERFORMANCE	RADAR METERS		CHECKED BY
				CRYSTAL CURRENT	TRANSMITTER CURRENT	
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			
		YDS.	DB. DOWN			

RADAR PERFORMANCE CHECK SHEET

RADAR MODEL __________ SERIAL __________ LOCATION __________

ECHO BOX TS-311B/UP, SERIAL __________ RADAR CONDITIONS:-PULSE LENGTH __________

TESTS MADE:-WITH DIRECTIONAL COUPLER __________ REP. RATE __________

WITH TEST ANTENNA __________ REC. BW. __________

LOCATION __________ RINGTIME __________

DATE	TIME	OBSERVED RINGTIME	RADAR PERFORMANCE	RADAR METERS		CHECKED BY
				CRYSTAL CURRENT	TRANSMITTER CURRENT	
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
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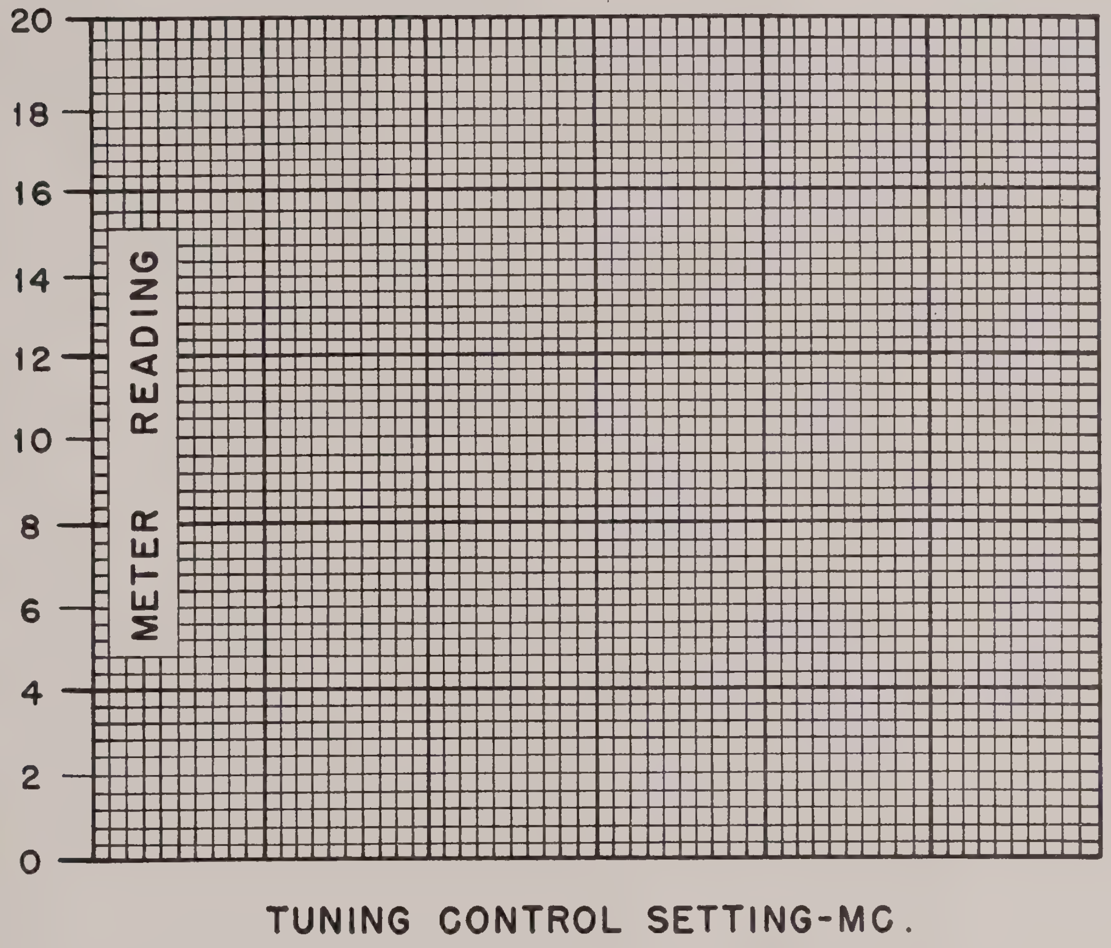
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			
		YDS.	DB.DOWN			

SPECTRUM ANALYSIS CHART



RADAR MODEL ____________________

RADAR SERIAL ____________________

ECHO BOX TS-311B/UP SERIAL ____________________

SHIP OR STATION ____________________

TESTED BY ____________________

DATE ____________________

RADAR CONDITIONS ____________________

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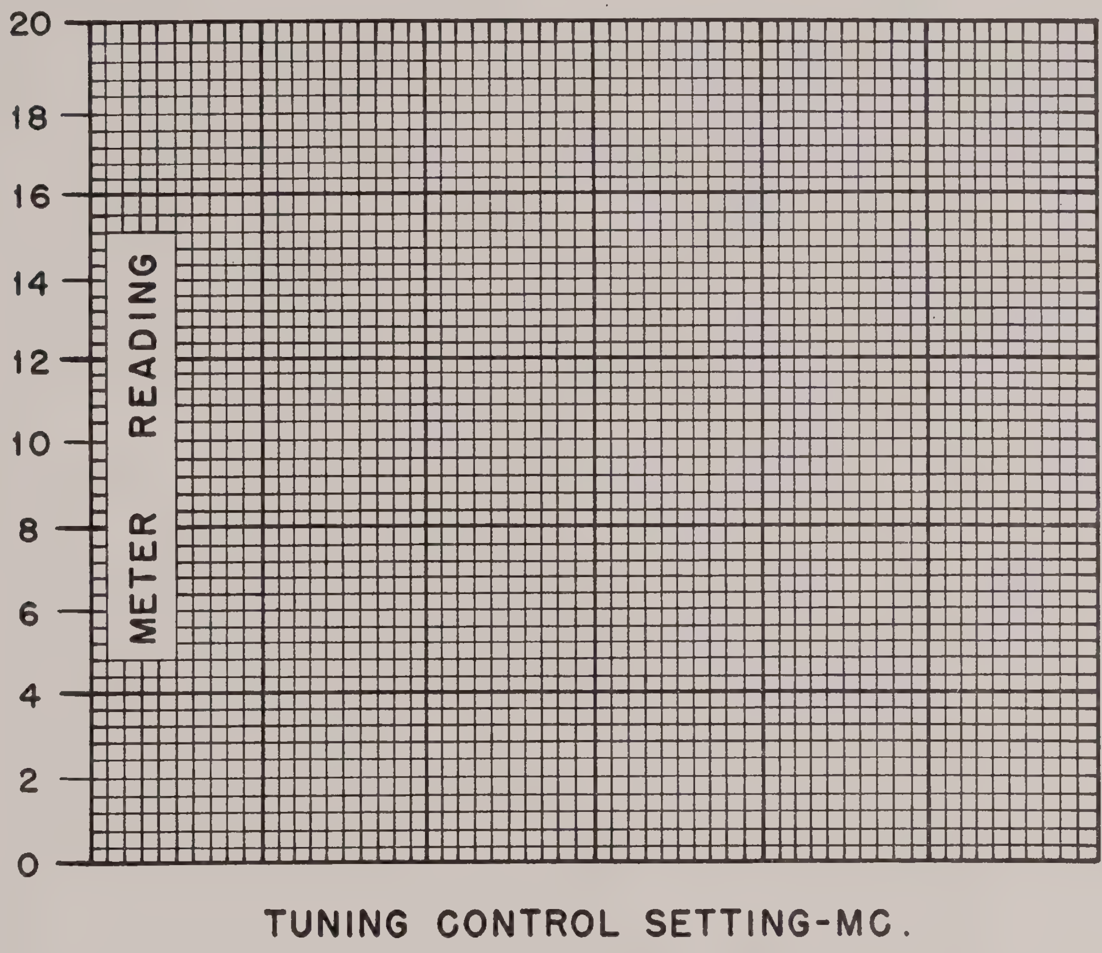
SPECTRUM ANALYSIS CHART



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RADAR SERIAL ______________________________

ECHO BOX TS-311B/UP SERIAL ______________________________

SHIP OR STATION ______________________________

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DATE ______________________________

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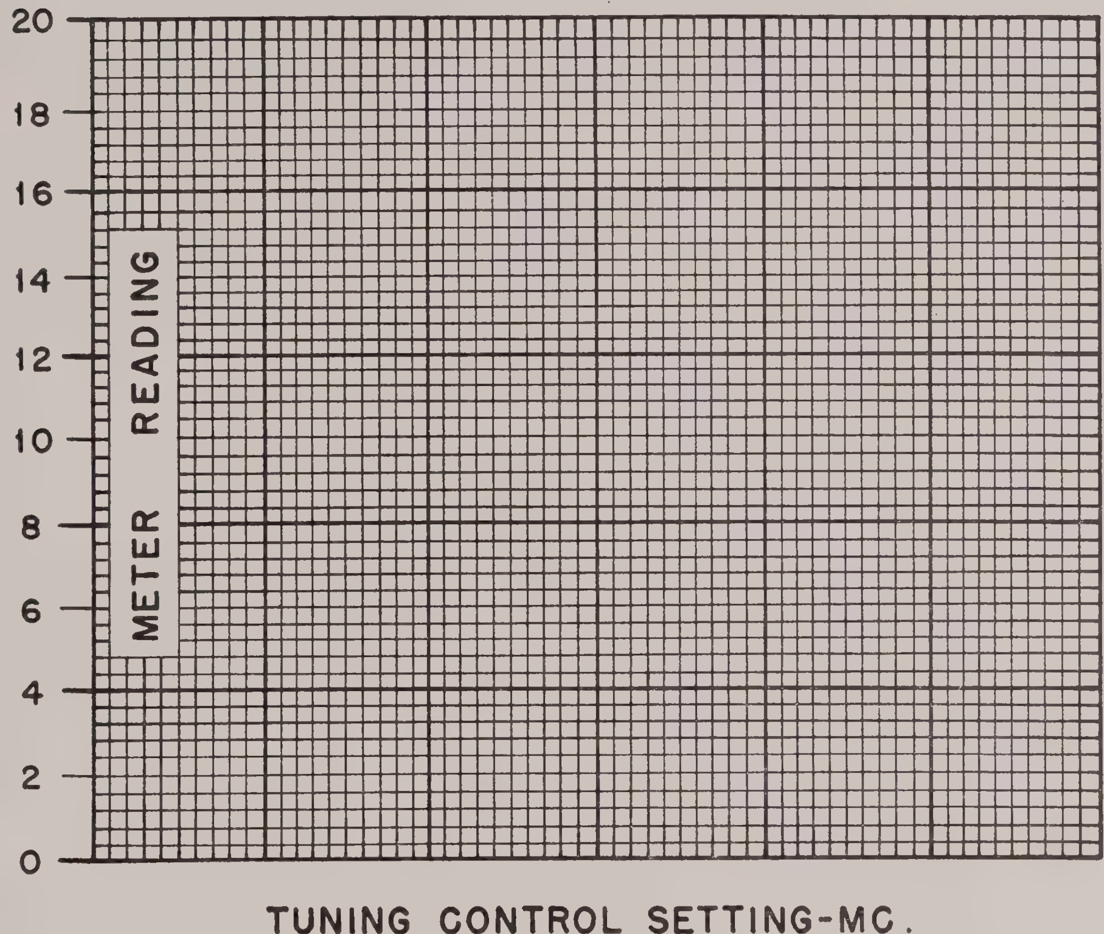

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RADAR SERIAL ______________________________

ECHO BOX TS-311B/UP SERIAL ______________________________

SHIP OR STATION ______________________________

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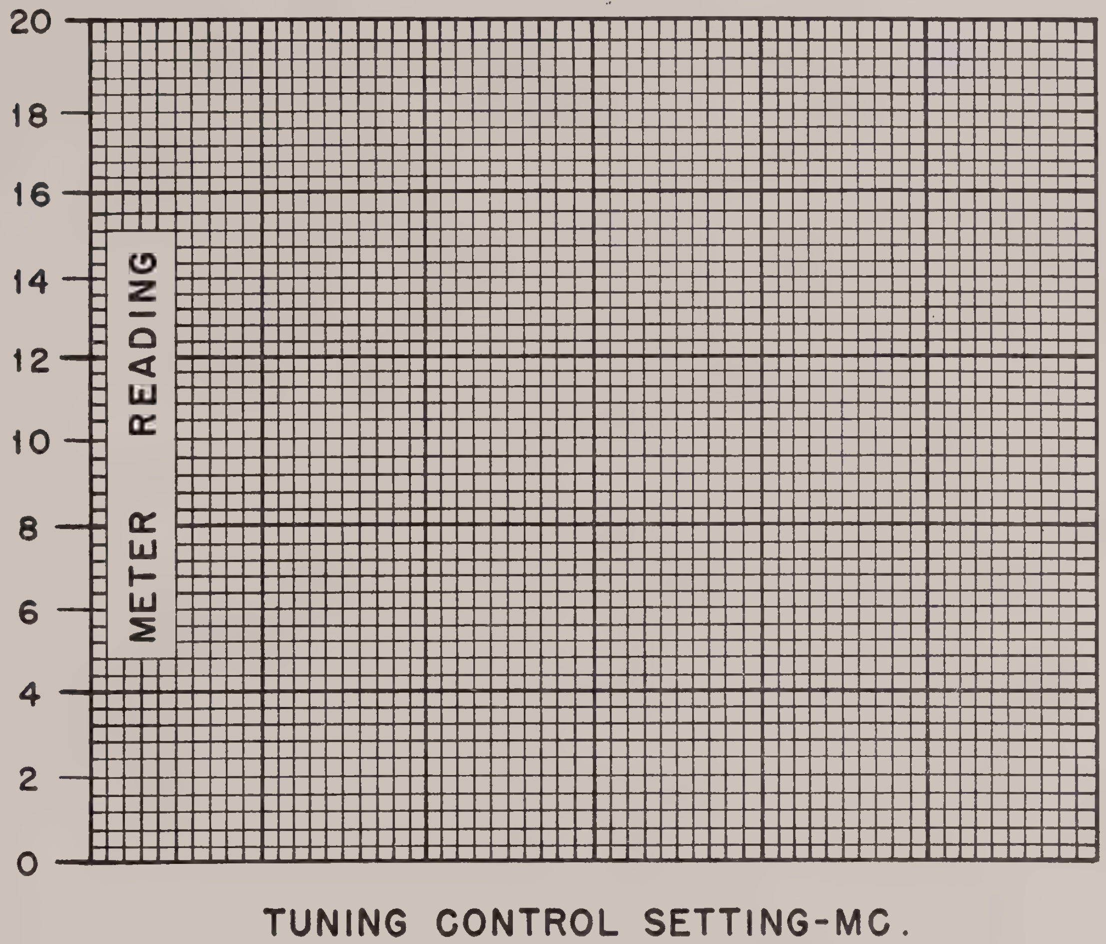

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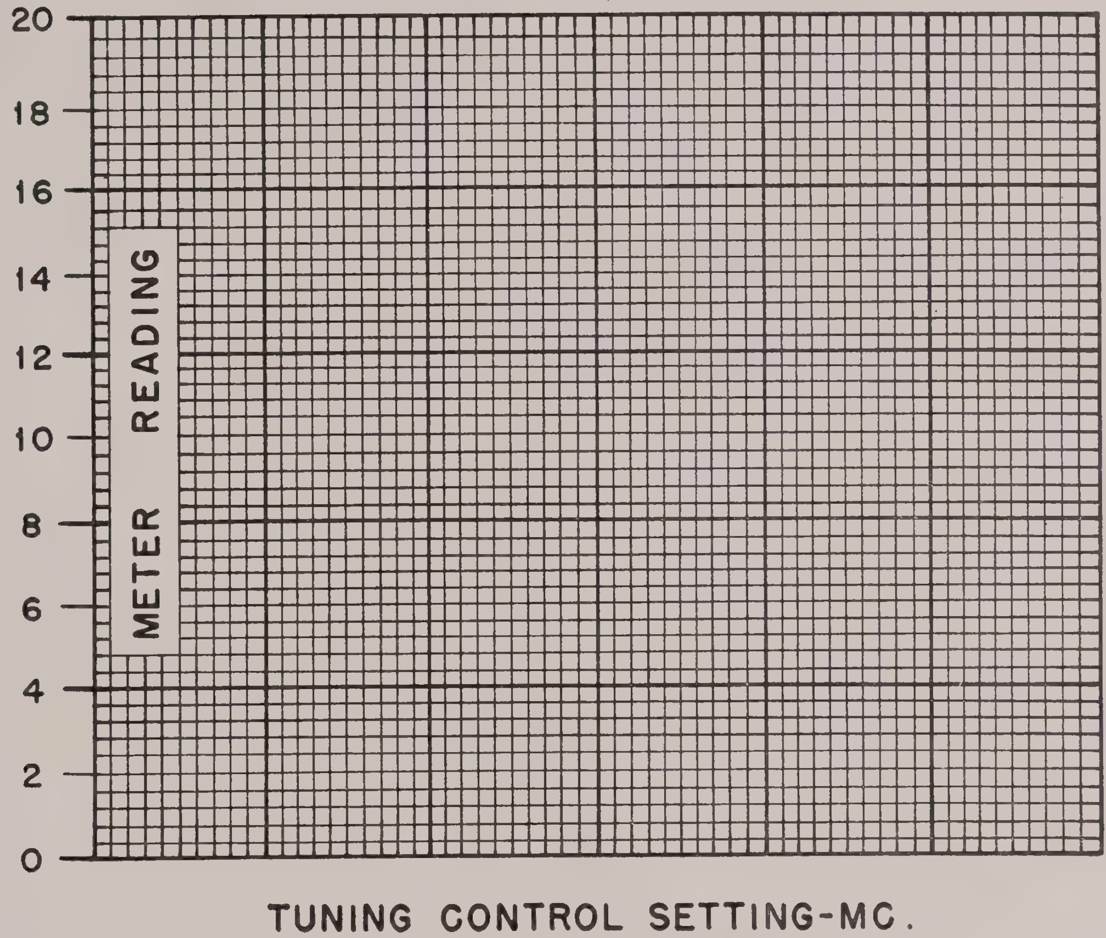

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RADAR SERIAL ______________________________

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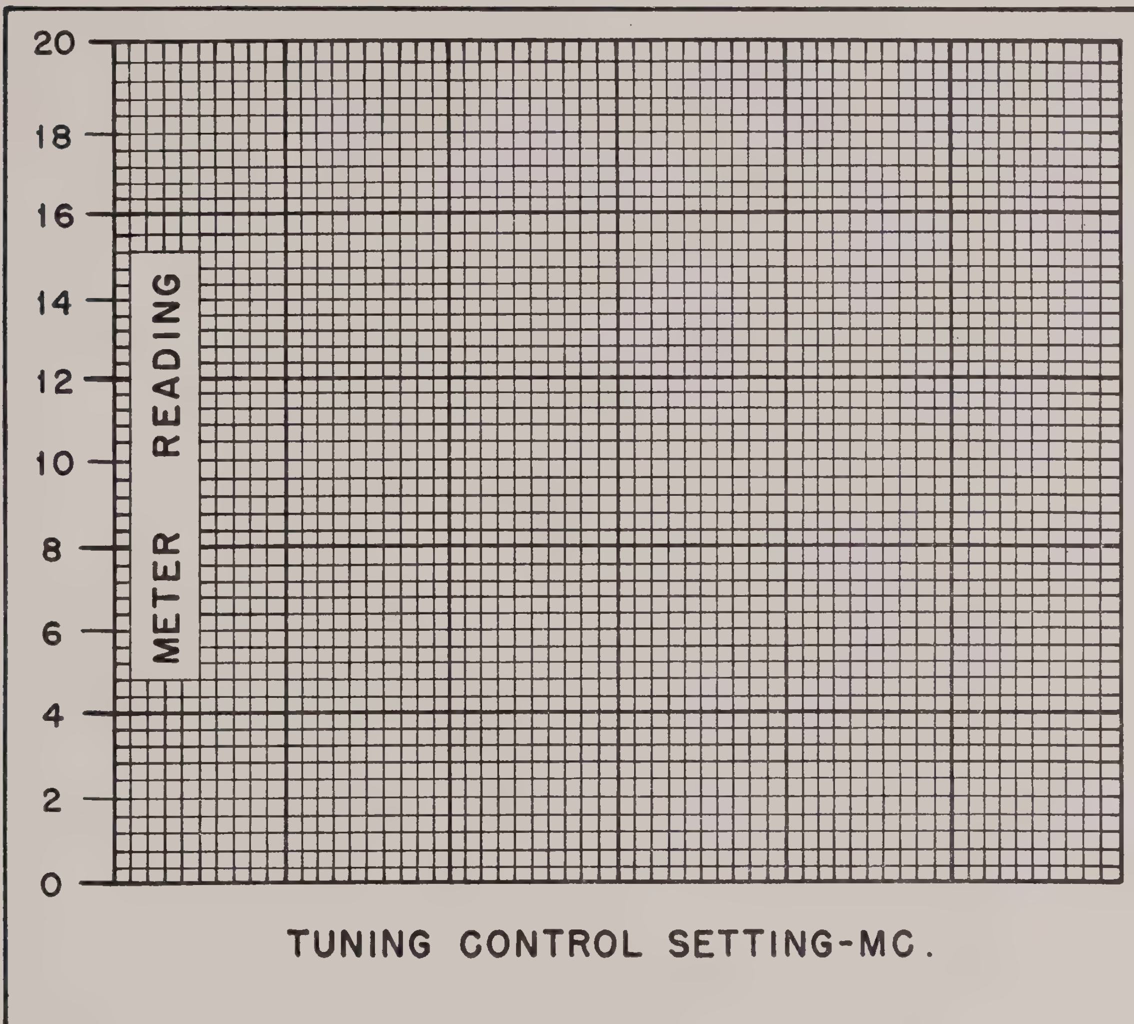

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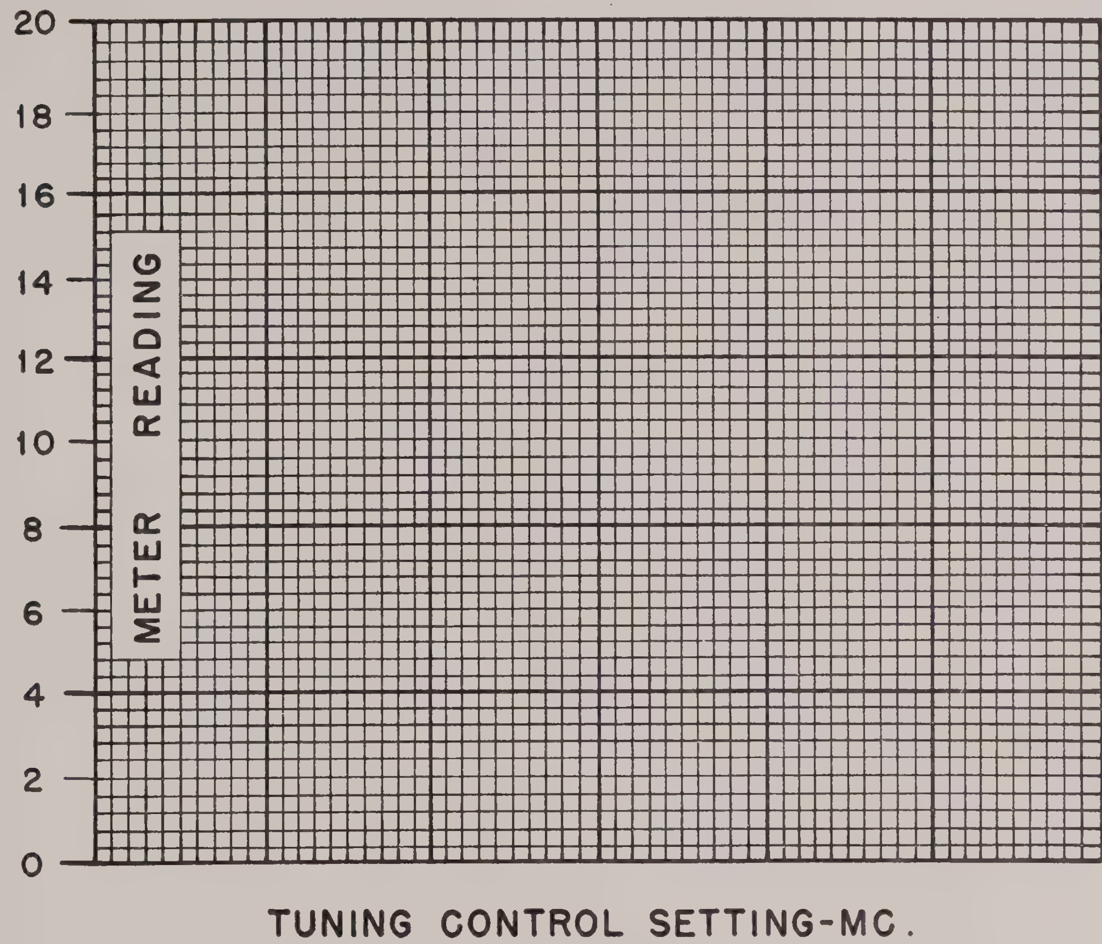

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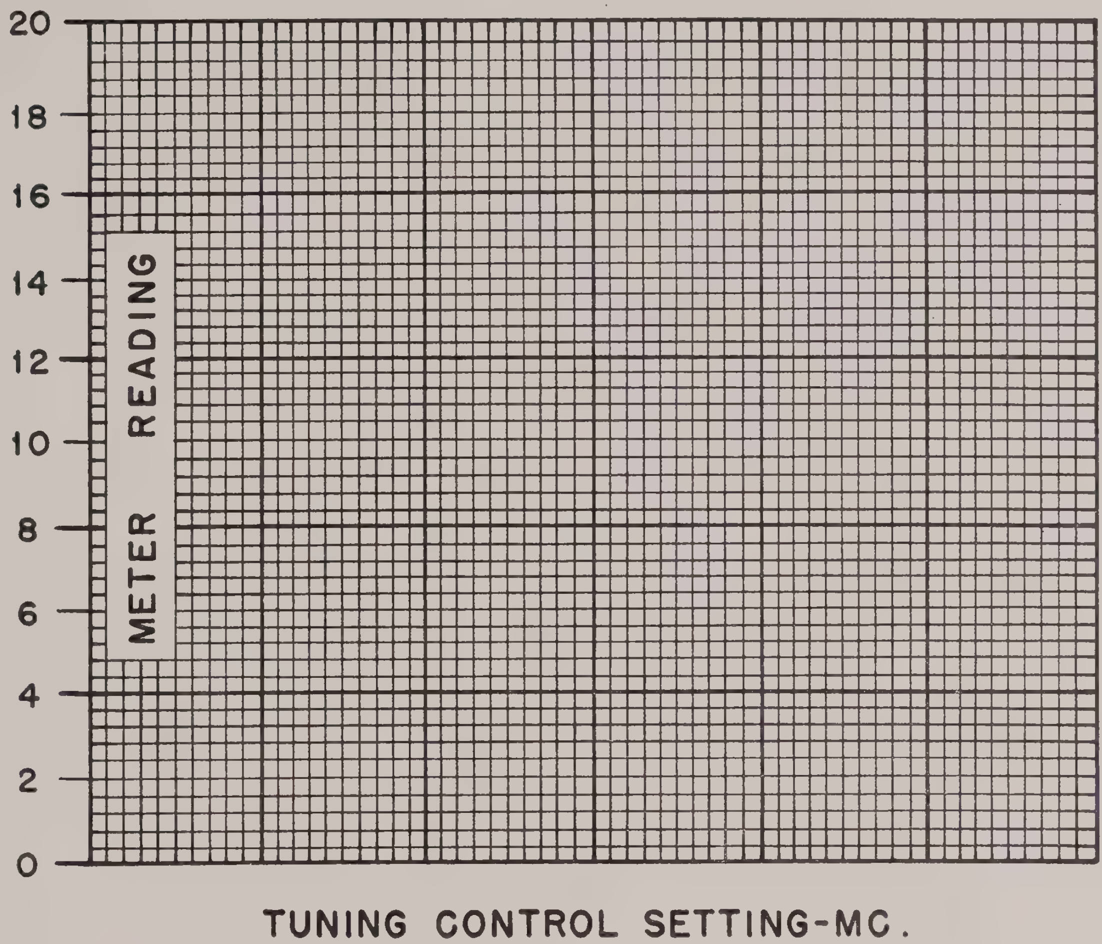

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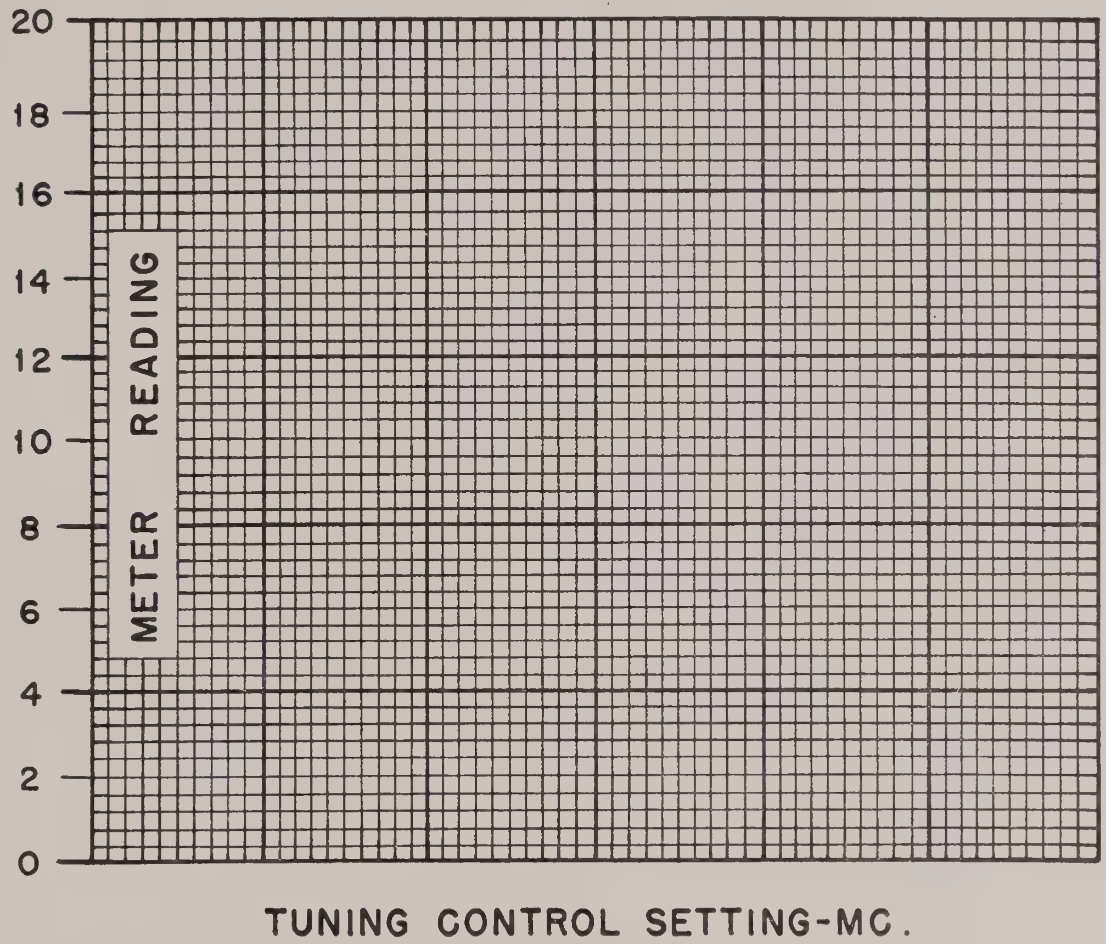

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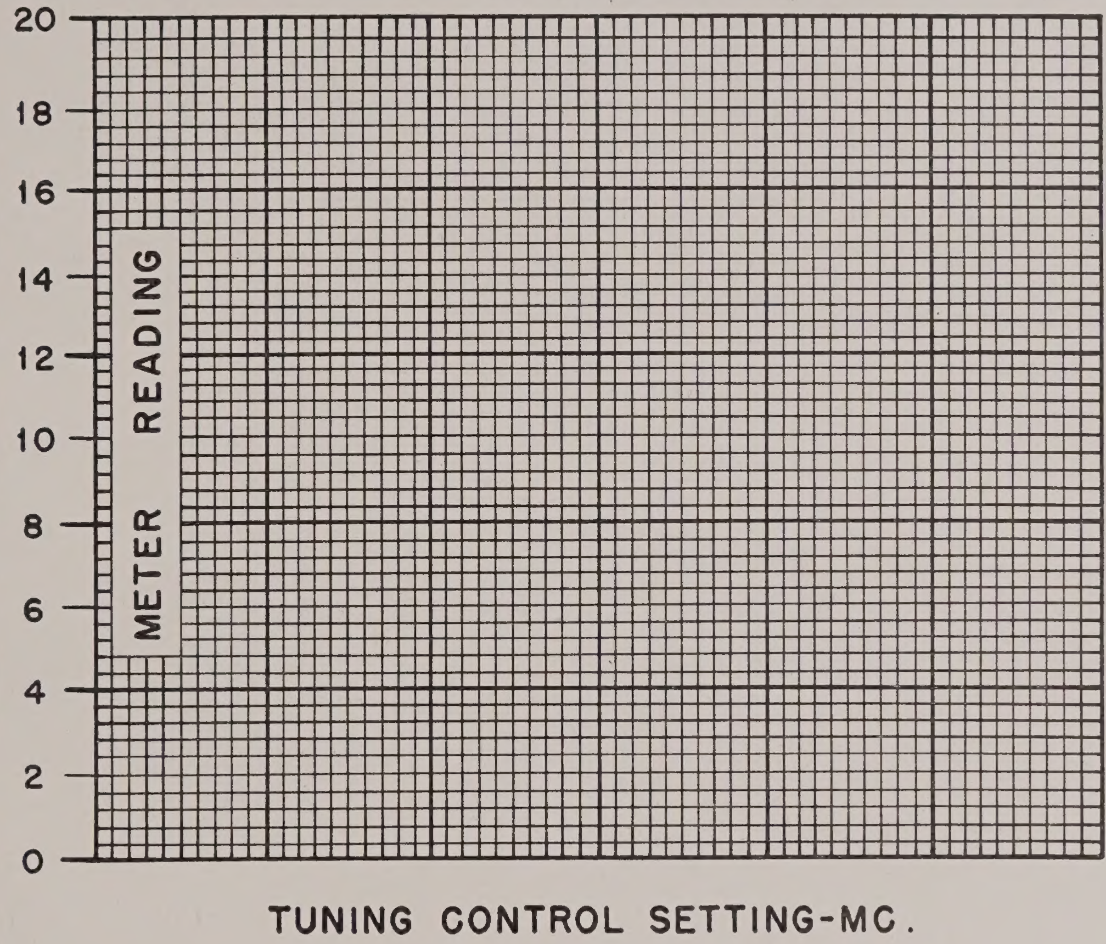

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